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*Stennis Space Center*

**Welcome  
to the  
NASA John C. Stennis Space Center  
Propulsion Test  
Customer Day 2002**



# Tuesday Morning Agenda

*Stennis Space Center*

- Agenda/Logistics Gary Taylor/Propulsion Test Directorate
- Welcome/Opening Comments Mark Craig/Deputy Director, Stennis Space Center
- Stennis Space Center (SSC) Video Tape
- SSC Overview Robert Lightfoot/Director, Propulsion Test Directorate
- Overview of A/B Test Complex Gary Taylor/Propulsion Test Directorate
- Overview of E Complex Bartt Hebert/Propulsion Test Directorate
- Overview of Test Support Services Stan Gill/Propulsion Test Directorate
- Engineering and Test Technology Shamim Rahman/Propulsion Test Directorate
- Rocket Propulsion Test Management Board (RPTMB) Mike Dawson/Manager, Propulsion Test Program Office



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# John C. Stennis Space Center

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*Stennis Space Center*

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## Unique Environment

- 30 Federal and State Agencies for Synergy and Cost-Sharing
- Government Managed, Contractor Operated
- DoD/NASA Working Relationship
- Commercial Customer Experience from Propulsion Test and Remote Sensing

## Proven Capability

- Business Systems, Service Providers and Infrastructure in Place
- Experienced Work Force
- 125,000 Acre Buffer Zone
- Environmental Relationship with State

## Strong Community Support

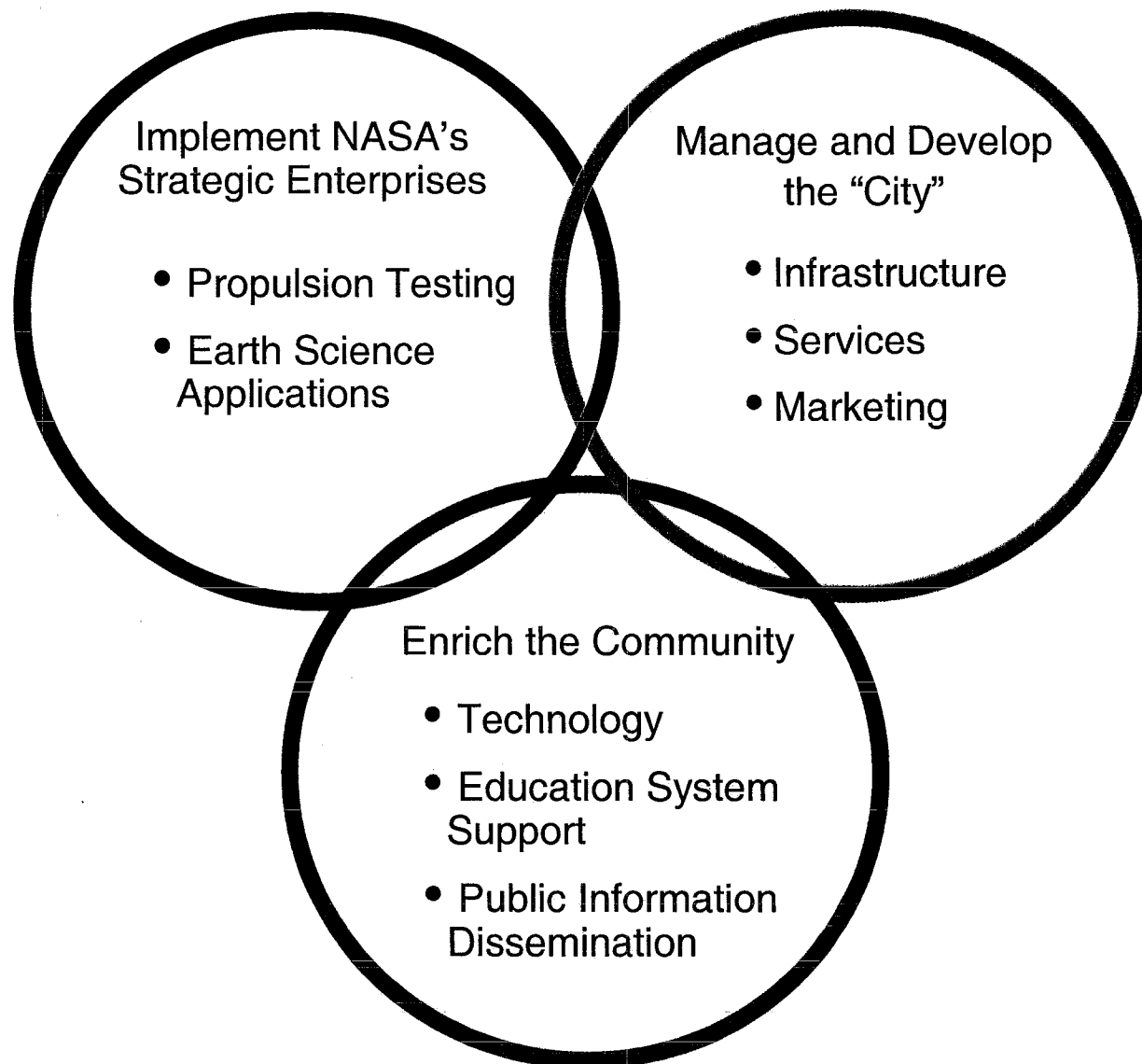
- A Recognized Contributor to Two States' Well Being
- Mississippi and Louisiana State Agency Presence on Site
- "Partners for Stennis" Local Support





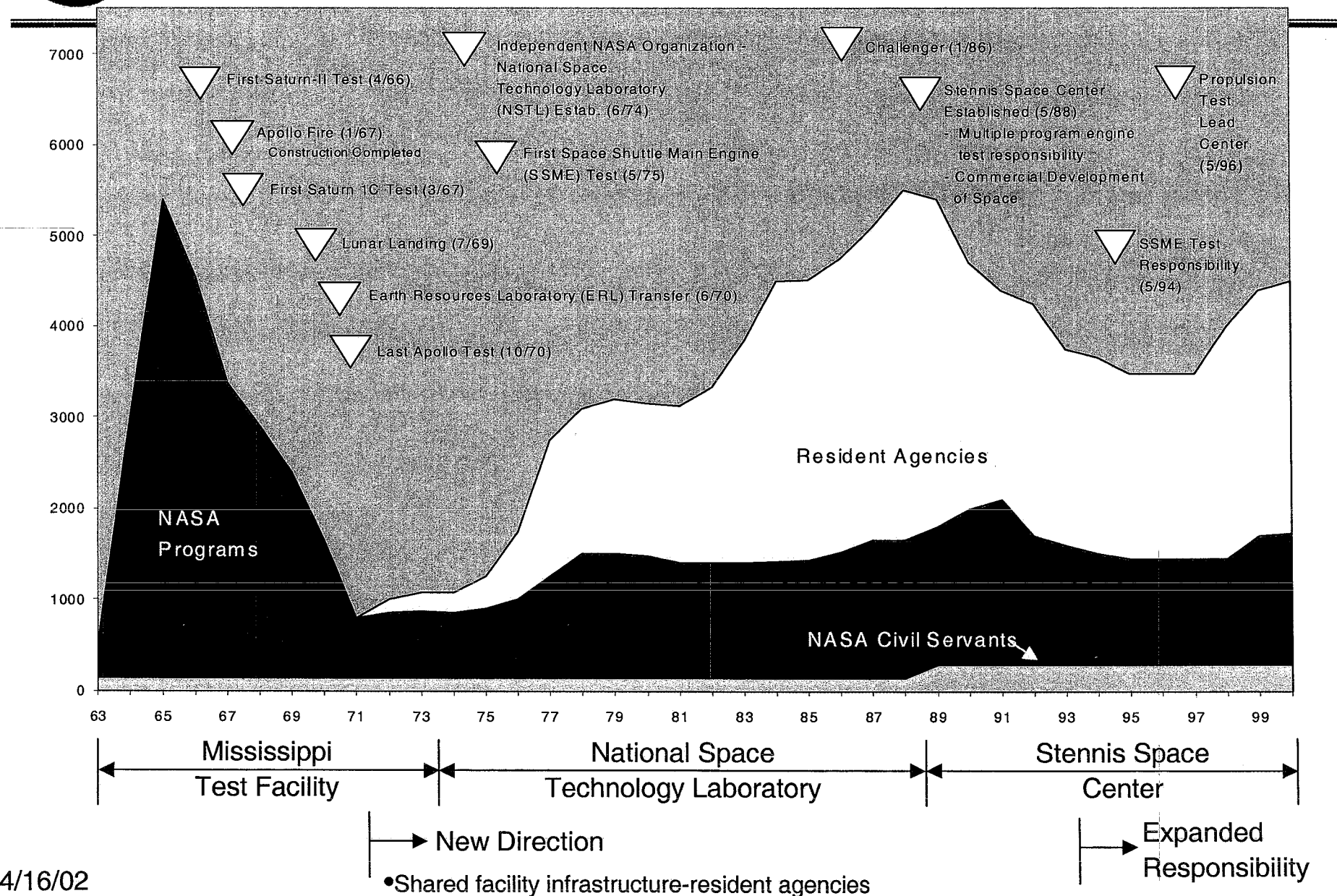
# NASA Activity at Stennis

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# Stennis Space Center Workforce/History





# Stennis Space Center Workforce

Stennis Space Center

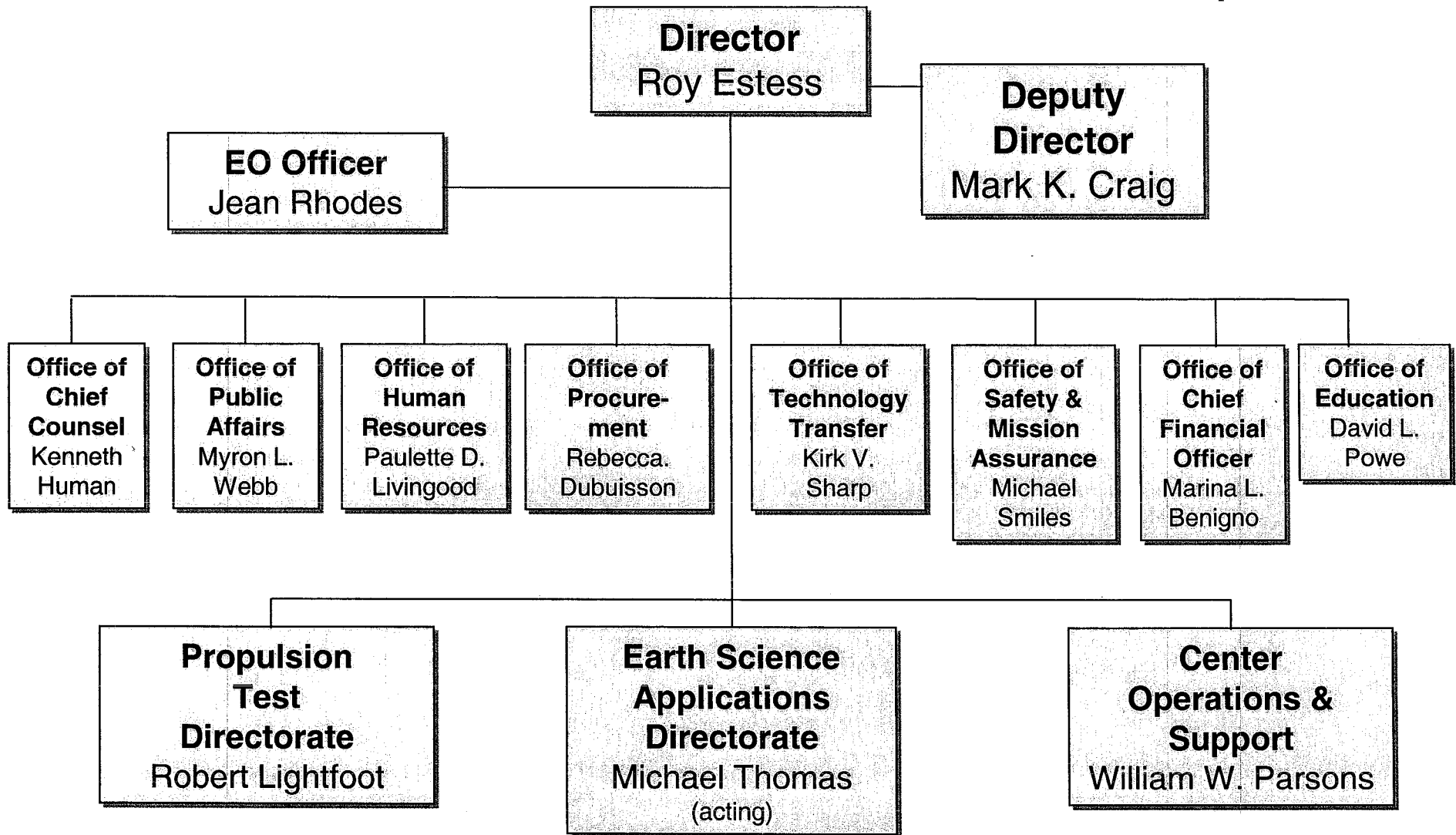
## 2001 Workforce at John C. Stennis Space Center

• NASA and Contractors	1,730
– SSC Federal Civil Servants	287
– Contractor and Other	1,443
• Department of Defense and Contractors	1,279
– Department of Navy	1,205
– Department of Army	74
• Department of Commerce and Contractors	180
• Other Resident Agencies	1,311
Total	4,500



# Stennis Space Center Senior Management

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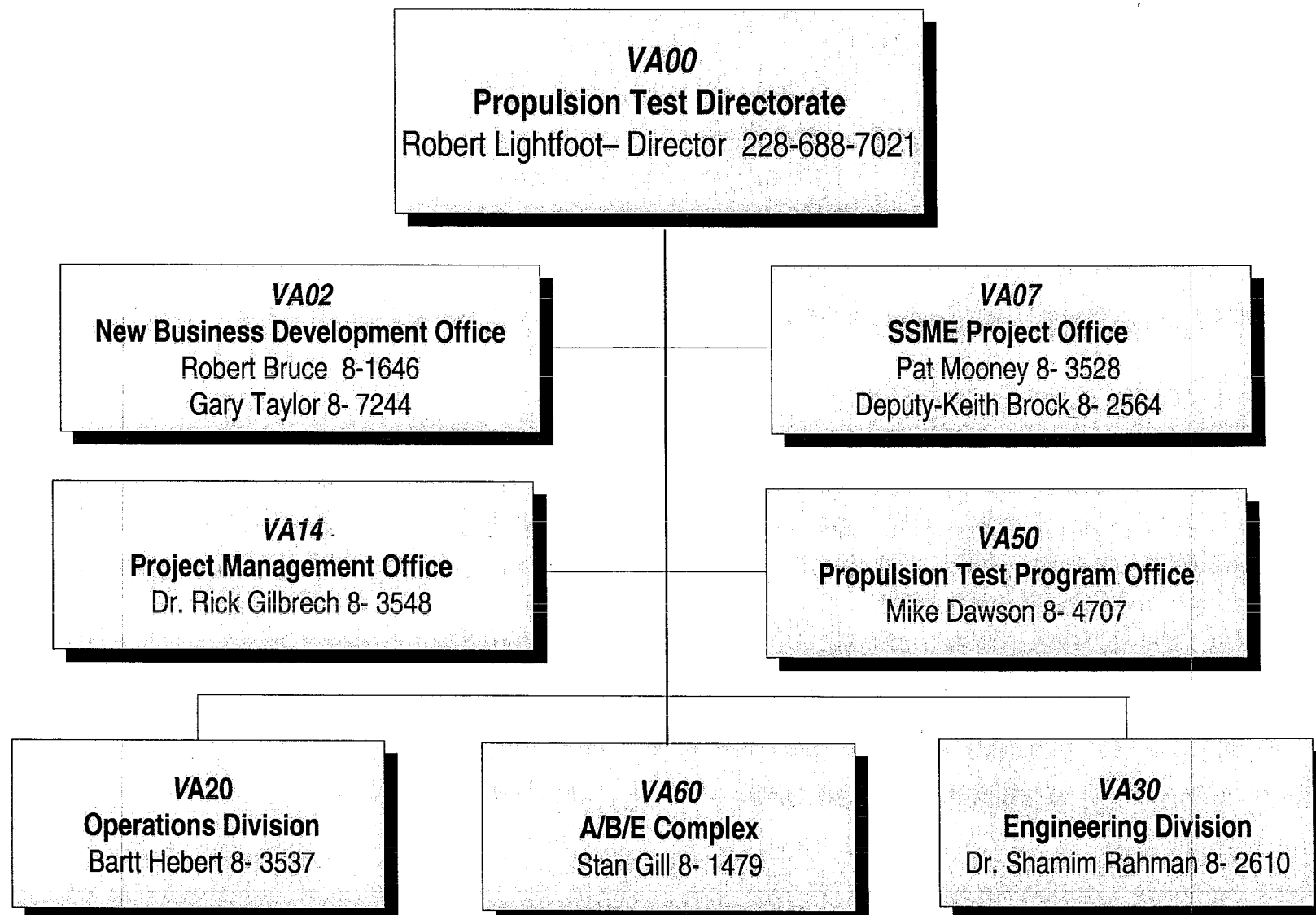




# Propulsion Test Directorate

## NASA John C. Stennis Space Center

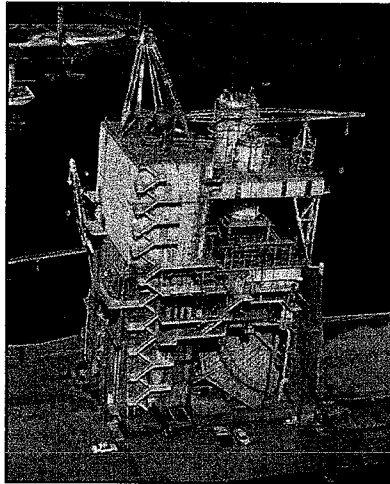
*Stennis Space Center*



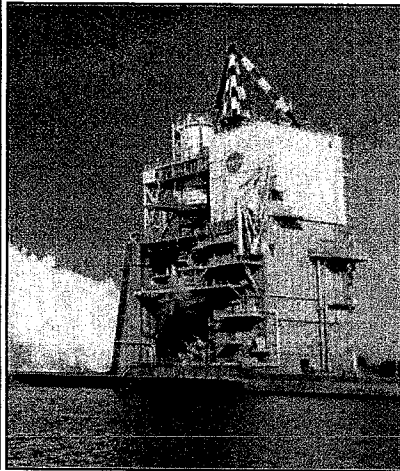


# SSC Test Stands

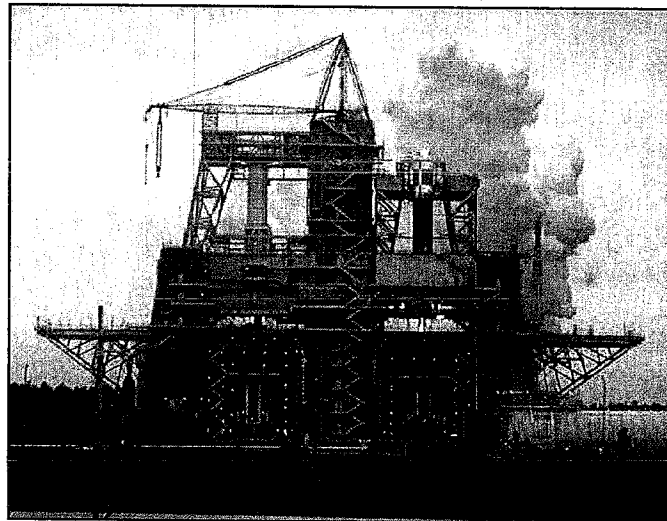
Stennis Space Center



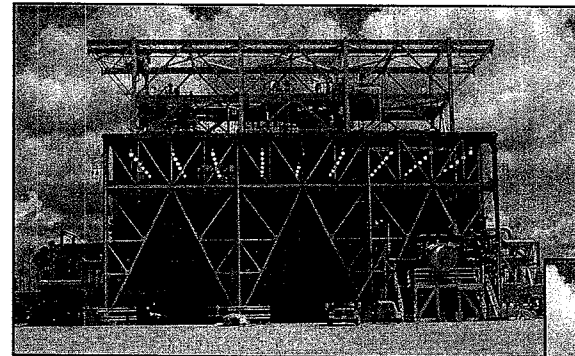
A-1



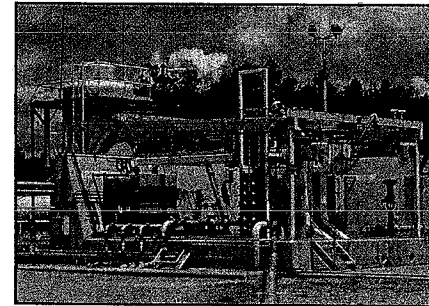
A-2



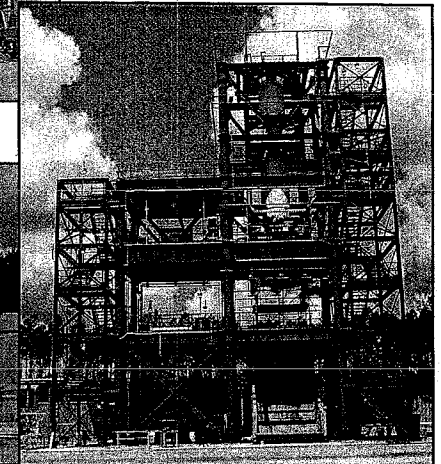
B-1/B-2



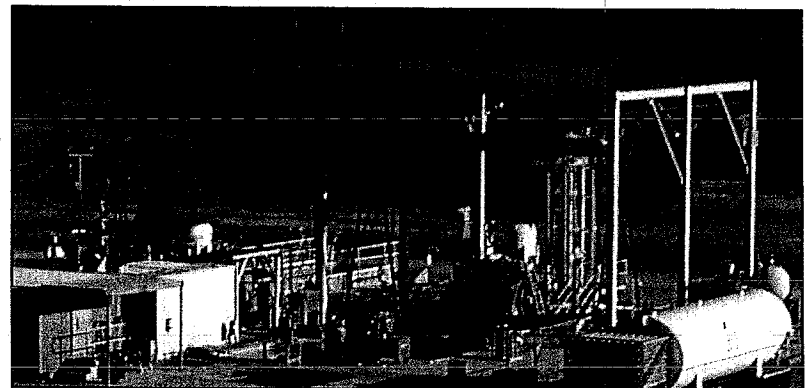
E-1



E-2



E-3





# Test Stand Utilization Schedule

CALENDAR YEARS

Stennis Space Center

TEST FACILITY	01				02				03				04				05			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A1	X-33		Maint		SSME		Active Standby													
	SSME				Maint				SSME											
A2	RS-68																			
B1	Mothballed																			
B2	CBC																			
E1 Cell 1	250K Hybrid				33		COBRA PB		Active Standby											
					IPD-LH2 PB/TP				Active Standby											
	IPD-LOX Turbo Pump				IPD Integrated Systems				Active Standby											
E2 Cell 1	LMA PLUS				33		Active Standby													
E2 Cell 2	S		Active Standby		USFE		Active Standby													
E3 Cell 1	HY3R				MK-57 TPA		Active Standby													
E3 Cell 2	E/R CB II		E/R CB III		E/R CB III		Active Standby													

Occupied
  Project Pending
  Available
  Construction/Activation

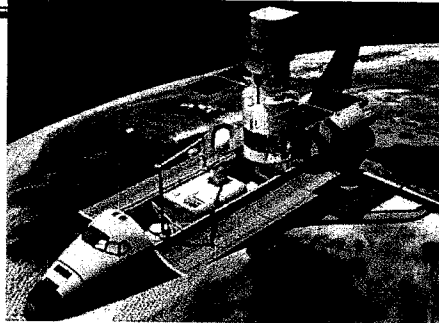
4/16/02

3/15/02



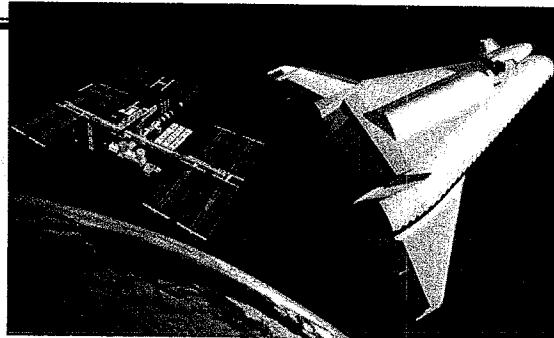
# NASA Programs

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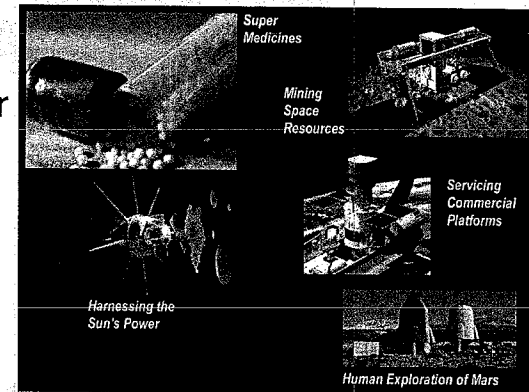
## Today: Space Shuttle 1st Generation RLV

- ◆ Orbital Scientific Platform
- ◆ Satellite Retrieval and Repair
- ◆ Satellite Deployment



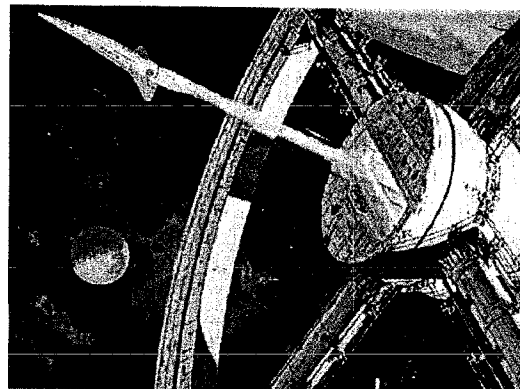
## 2010: 2nd Generation RLV

- ◆ Space Transportation
- ◆ Rendezvous, Docking, Crew Transfer
- ◆ Other on-orbit operations
- ◆ ISS, Orbital Scientific Platform
- ◆ 10x Cheaper
- ◆ 100x Safer



## 2040: 4th Generation RLV

- ◆ Routine Passenger Space Travel
- ◆ 1,000x Cheaper
- ◆ 20,000x Safer



## 2025: 3rd Generation RLV

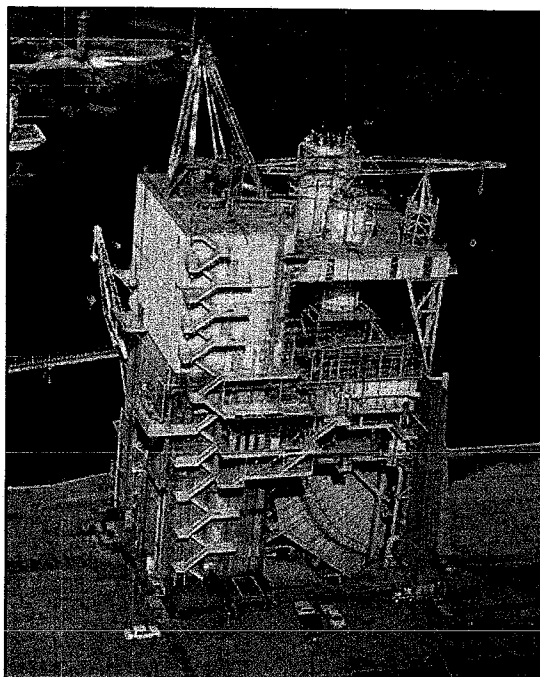
- ◆ New Markets Enabled
- ◆ Multiple Platforms / Destinations
- ◆ 100x Cheaper
- ◆ 10,000x Safer



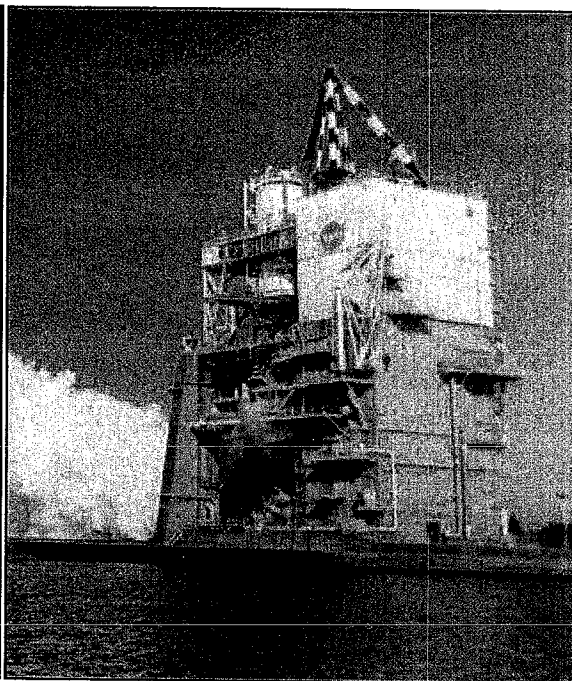


# A and B Test Complexes

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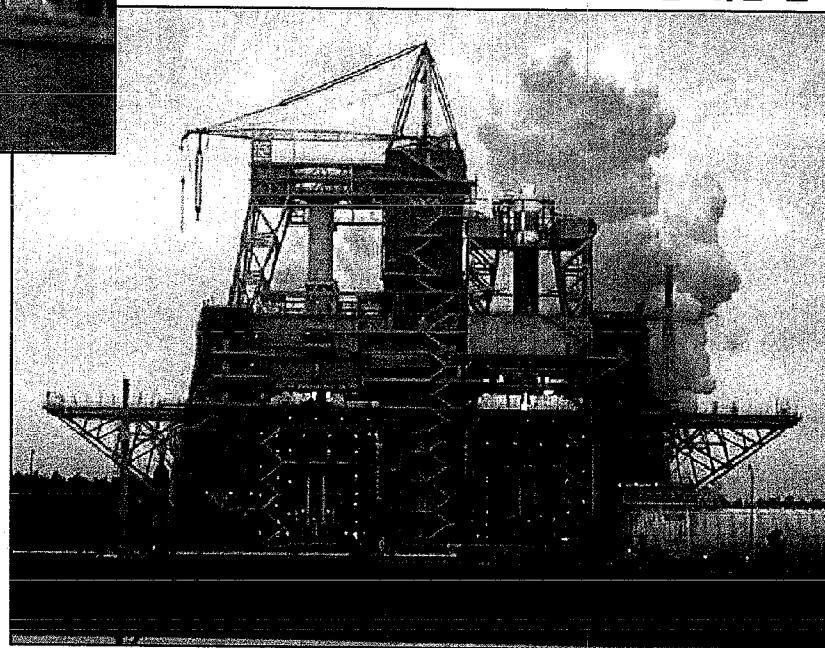
**A-1**



**A-2**

**Gary O. Taylor**  
**Propulsion Test Directorate**  
**NASA, Stennis Space Center**

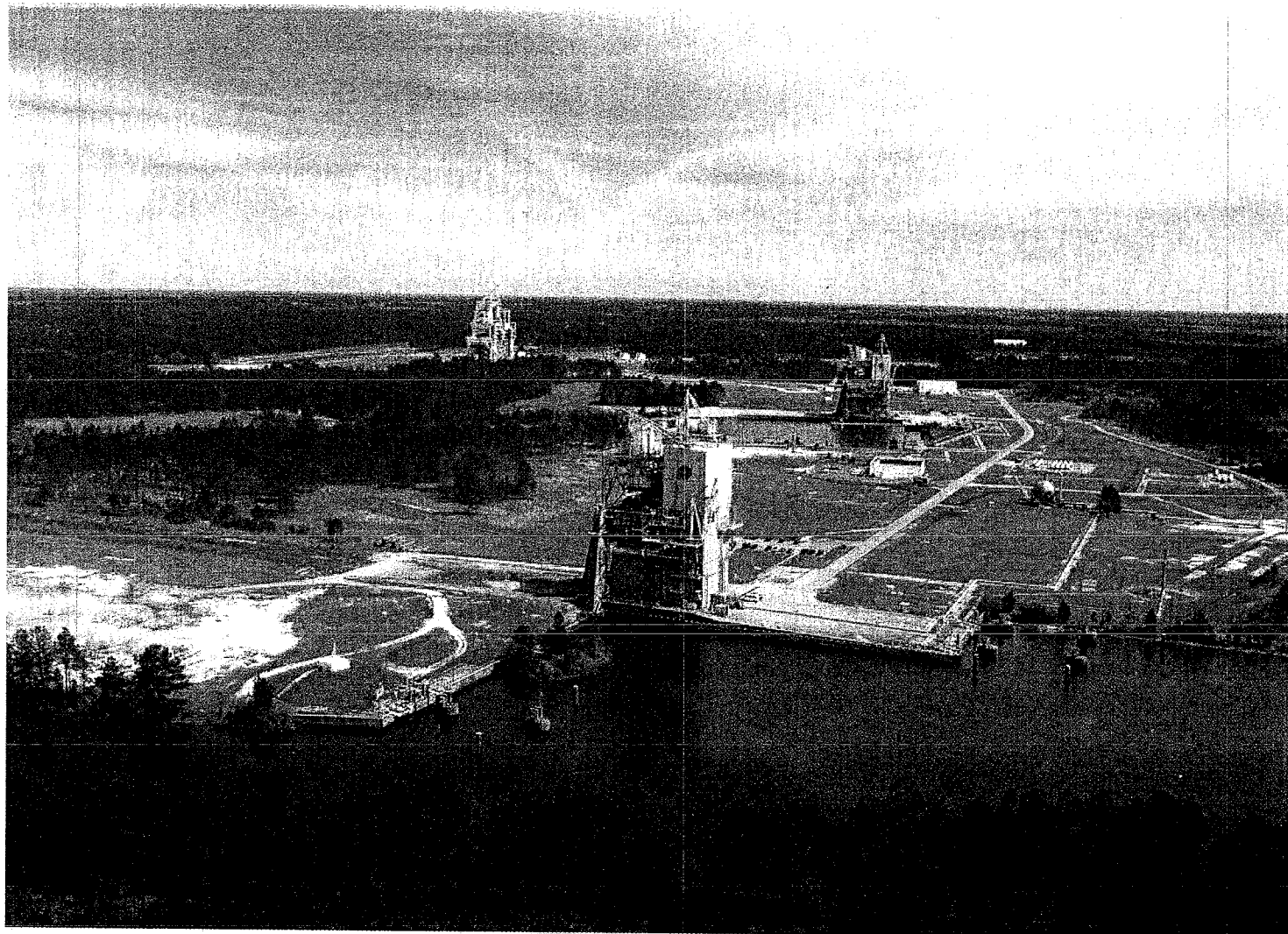
**B-1/B-2**





# A and B Test Complex

*Stennis Space Center*



4/16/02



# History of A/B Complex

*Stennis Space Center*

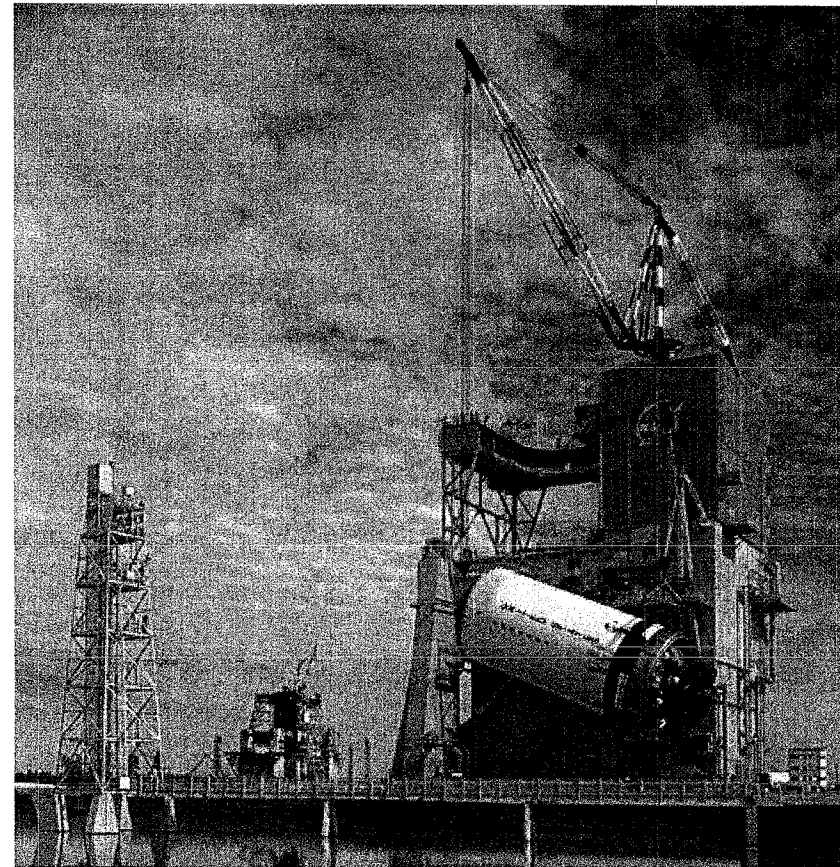
- Early 1960s – Early 1970s
  - National Rocket Testing Center
  - Support Flight Certification of 1<sup>st</sup> and 2<sup>nd</sup> stages of the Saturn V “Moon Rocket”
- Mid 1970s – Present
  - Support Space Shuttle Main Engine (SSME) development and certification test
  - Sea level, simulated altitude, and main propulsion cluster system (MPTA)
- Mid 1990s – Present
  - Continue SSME development and flight certification testing
  - Support government/government, agency/agency, and commercial programs
    - X-33 Program: Aerospike Engine Testing
    - NASA Research: MC-1 Engine/Assembly Testing
    - Commercial: RS-68 Engine/Stage Testing



# History of A Complex (A-1 & A-2)

*Stennis Space Center*

- Apollo Saturn V:
  - Second Stage (S-II) Testing
  - First Stage Test in April 1966
  - Stage:
    - Five J-2 engines
    - 1.15 M-lb thrust at altitude
    - LOX/LH<sub>2</sub>
    - 15 acceptance tests
    - 27 total static firings

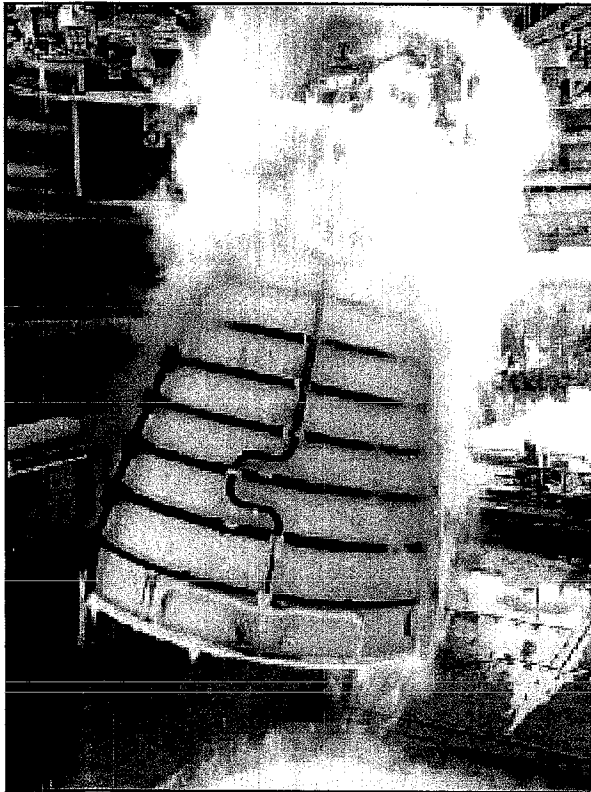


**Saturn V Second Stage is Lifted Into  
The A-2 Test Stand**



# History of A Complex (A-1 & A-2)

*Stennis Space Center*



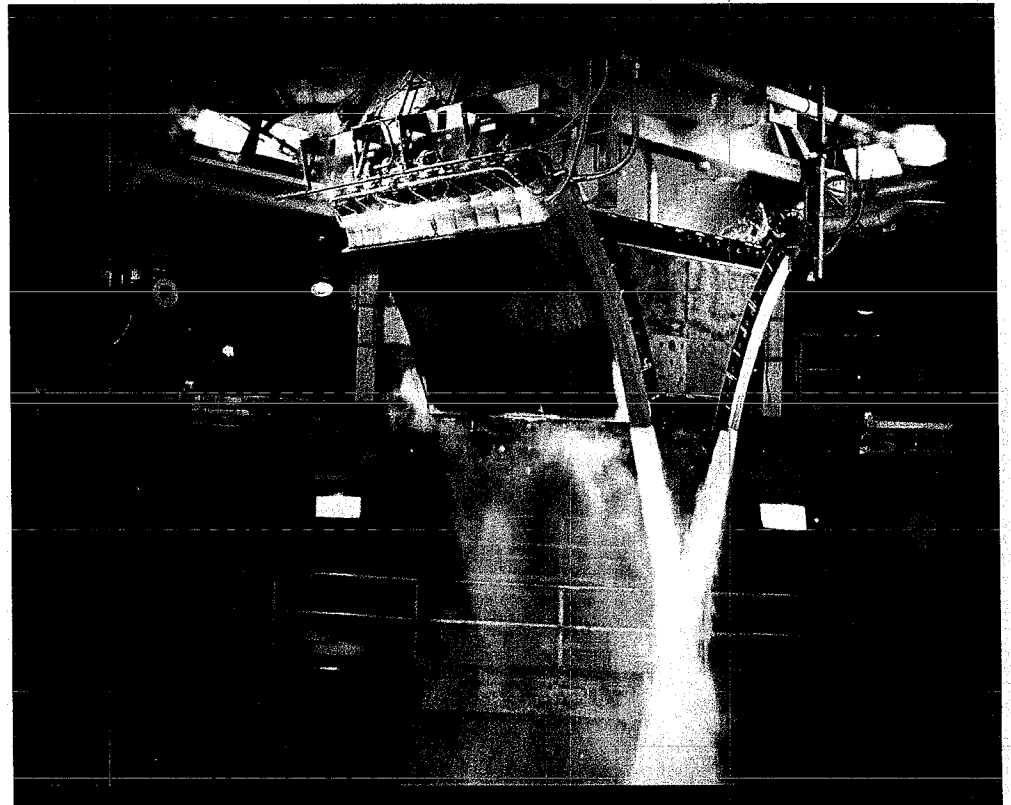
- Space Shuttle Main Engine (SSME):
  - Single engine testing
  - Sea level and simulated altitude test
  - First static firing in May 1975
  - SSME:
    - 375 K-lb thrust at sea-level (100% RPL)
    - LOX/LH



# History of A Complex (A-1 & A-2)

*Stennis Space Center*

- X-33/RLV Program
  - Linear Aerospike Engine Test
  - Testing initiated in 1998
  - Powerpack testing
  - Single and dual engine test
  - Completion in 2001
  - Engine:
    - 250K thrust
    - LOX/LH

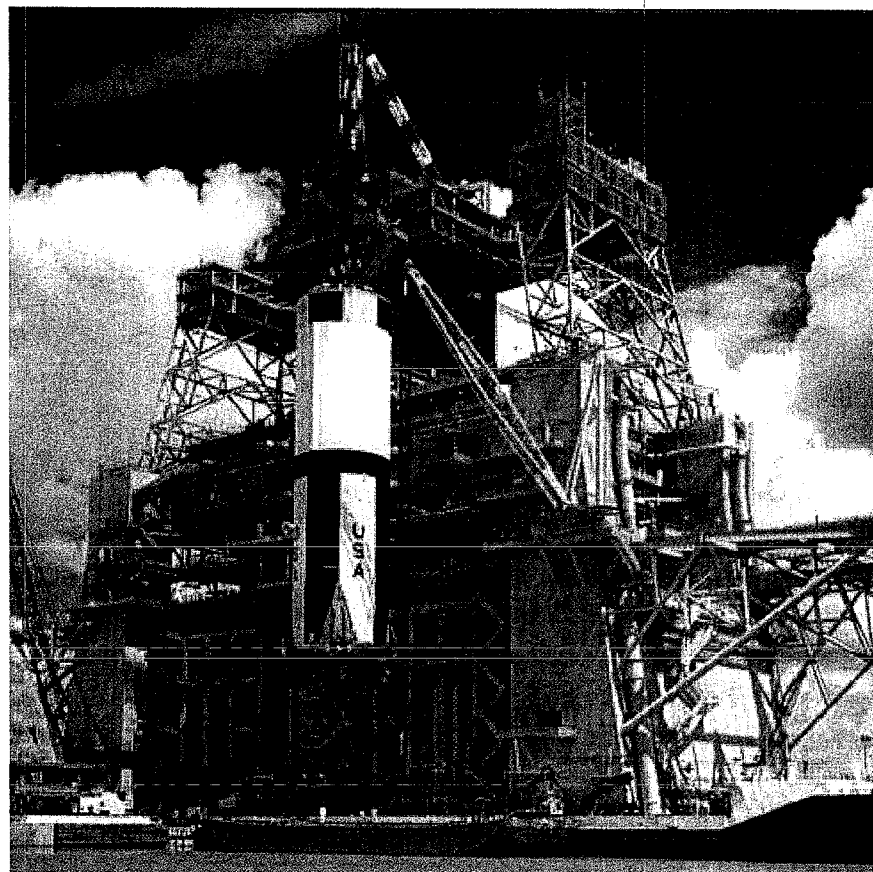




# History of B Complex (B-1 & B-2)

*Stennis Space Center*

- Apollo Saturn V:
  - 1<sup>st</sup> Stage (S-IC) Testing
  - First stage test in March 1967
  - Utilized the B-2 test position
  - Stage:
    - Five F-1 Engines
    - 7.5 M-lb thrust at sea level
    - RP-1/LOX
    - 15 total static firings



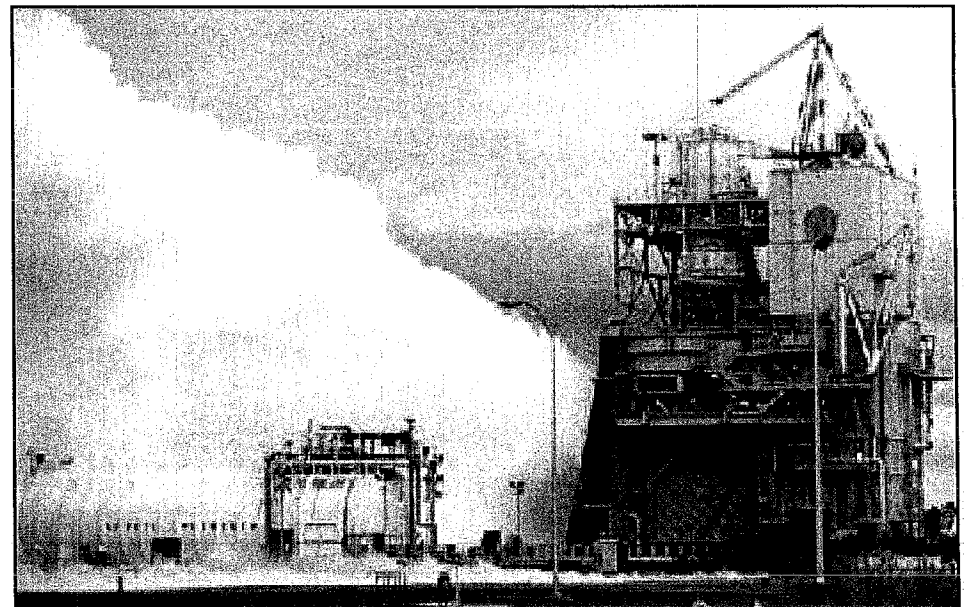
**Saturn V First Stage is Lifted Into B-2 Test Stand**



# History of B Complex (B-1 & B-2)

*Stennis Space Center*

- Space Shuttle Main Engine (SSME):
  - Single engine / Altitude simulated test
  - Utilized the B-1 test position
- Main Propulsion Test Article in B-2
  - 3 SSMEs
  - April 1978 through January 1981
  - 1.125 M-lb thrust at sea level
  - 18 total static test firing



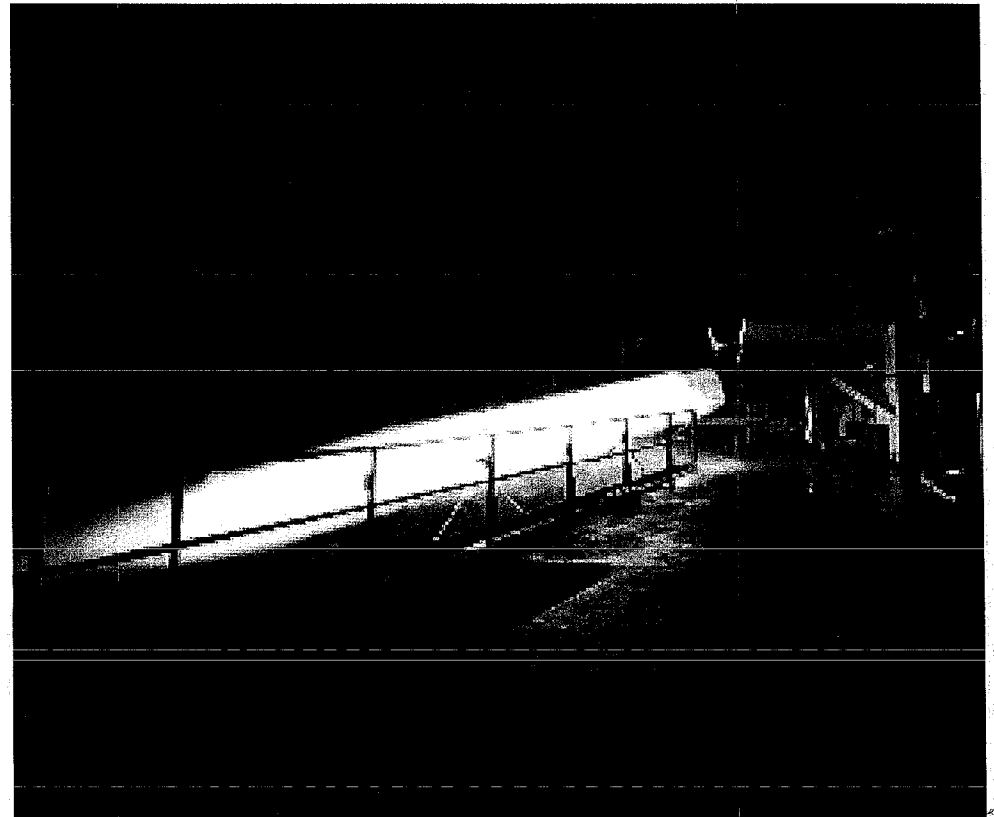




# History of B Complex (B-1 & B-2)

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- MC-1 (Fastrac Engine):
  - Low Cost Booster R & D
  - X-34 Technology Demonstrator Program
  - First test Dec. 1998 (B-2 upper deck)
  - Continued testing through Oct. 1999
  - Engine:
    - 60K Thrust
    - LOX/RP-1

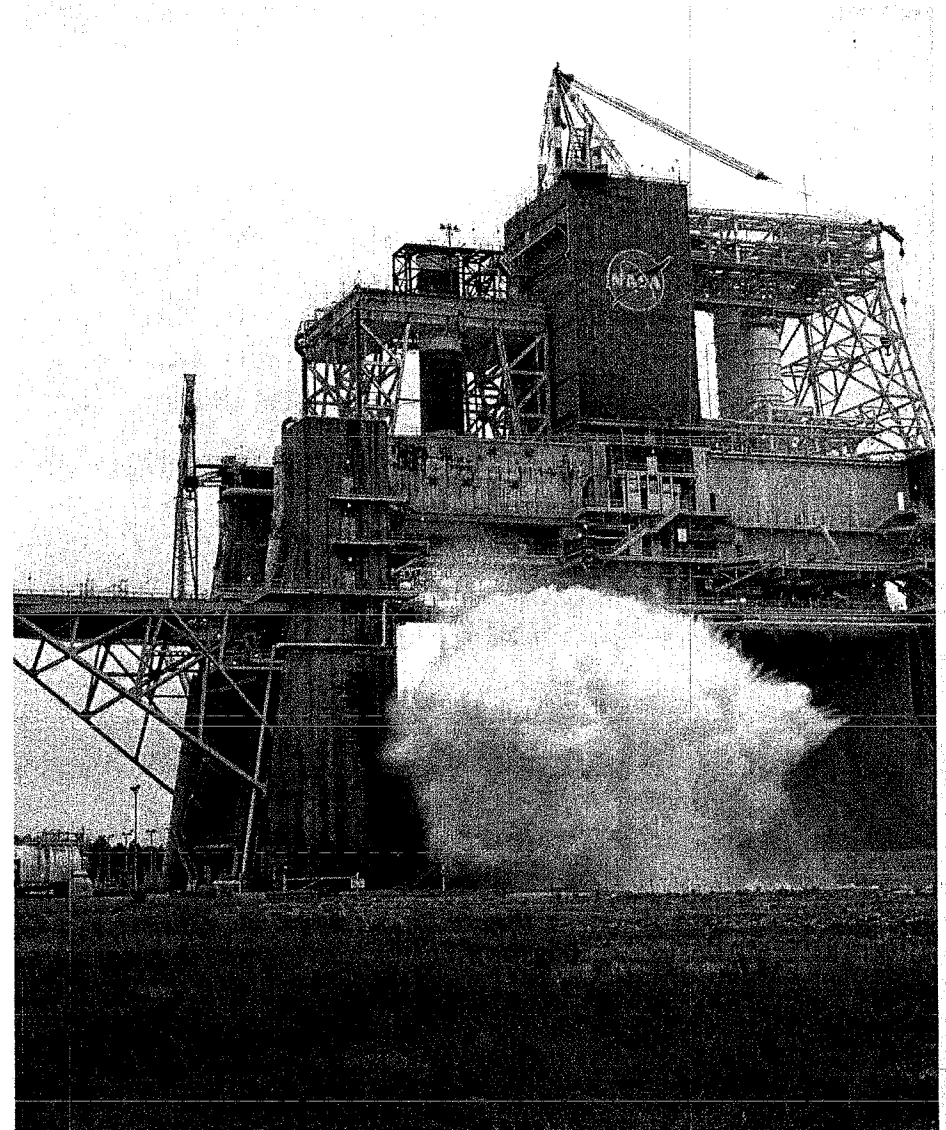




# History of B Complex (B-1 & B-2)

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- Combined Booster Core:
  - Delta IV Program
  - RS-68 Engine
    - 650K thrust
    - LOX/LH<sub>2</sub>

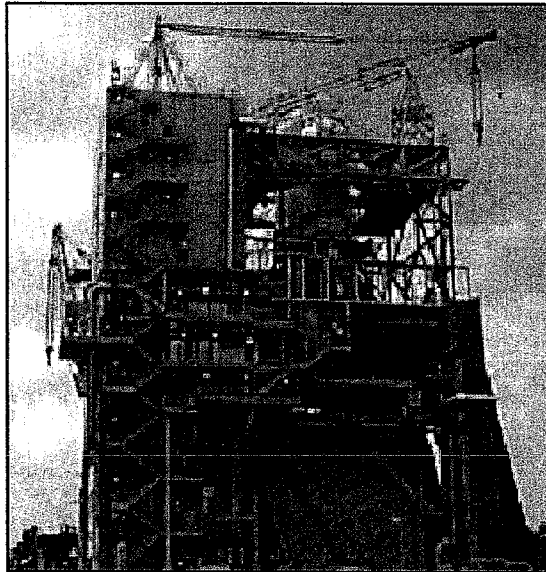




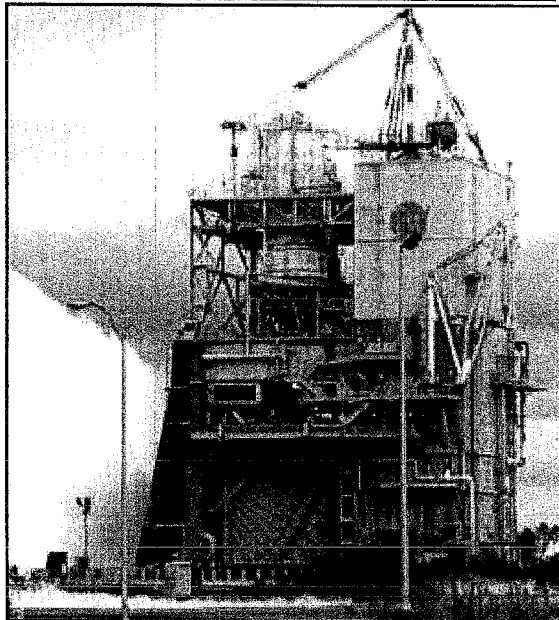
# A Complex Capabilities

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A-1



A-2



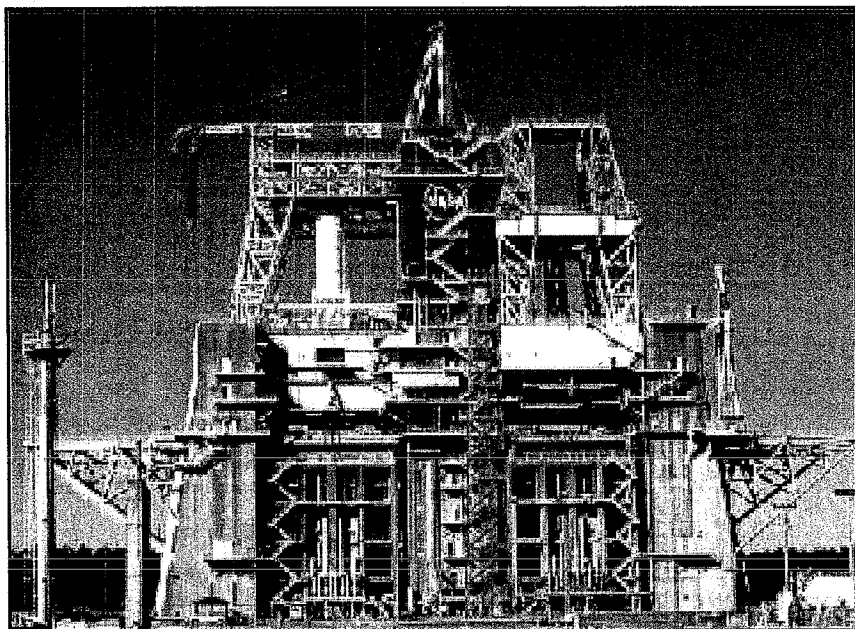
- A-1 & A-2 test stands similar in design
- Gimbal capability at A-1 (Sea level testing)
- Diffuser at A-2 (Simulated altitude testing)
- Designed for maximum dynamic load of 1.1 M lb thrust
- Supported by a dual capability test control center (TCC)
- Propellant run tanks
  - LH<sub>2</sub>: Water volume of 110K gallons, certified pressure of 50 psig
  - LO<sub>2</sub>: Water volume of 40K gallons, certified pressure of 250 psig
- Propellant barge docking stations
  - LH<sub>2</sub>: two (2)
  - LO<sub>2</sub>: two (2)



# B Complex Capabilities

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## B-1/B-2



- B-1/B-2 is a dual-position test stand
- Sea level and simulated altitude testing
- Designed for maximum dynamic load of 11 M-lb thrust
- Shared Test Control Center (TCC)
- Propellant run tanks
  - LH<sub>2</sub>: Water volume of 90K gallons, certified pressure of 66 psig
  - LO<sub>2</sub>: Water volume of 49.5K gallons, certified pressure of 110 psig
- Propellant barge docking stations
  - LH<sub>2</sub>: three (3)
  - LO<sub>2</sub>: three (3)

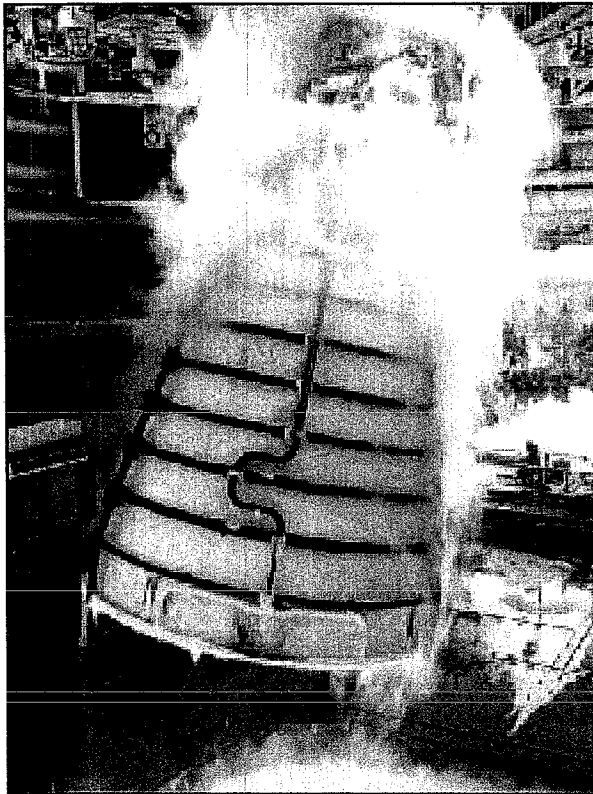


# Current Programs at A/B Complex

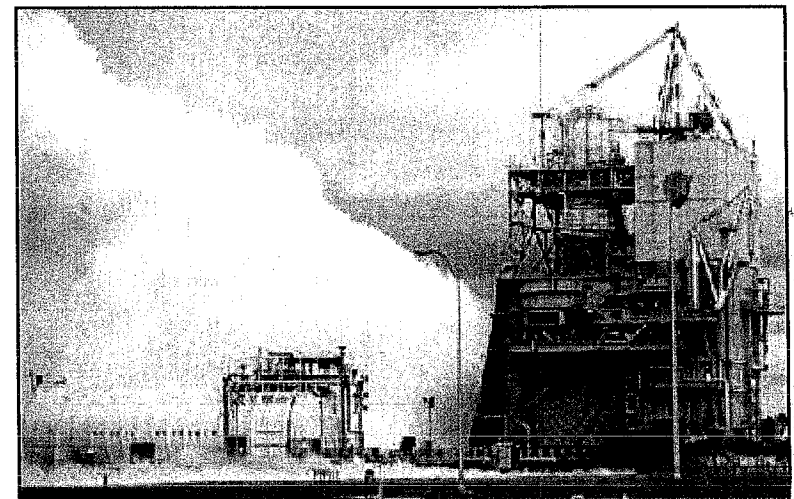


# Space Shuttle Main Engine

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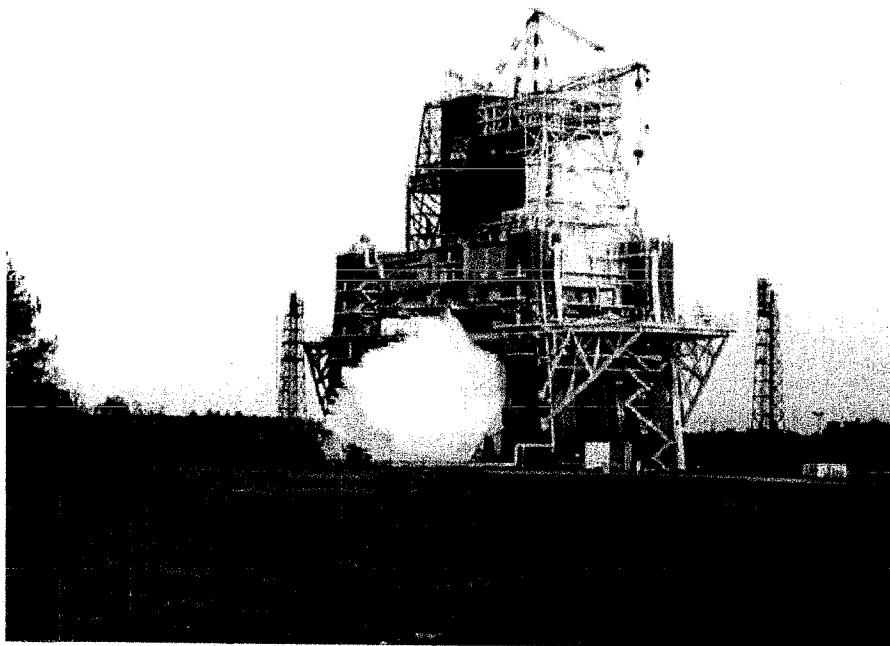
- Location
  - Transitioning to A-1 during A-2 modifications
- Scope
  - Acceptance Testing for Flight Program
  - Demonstrated Reliability Testing for Block II Engines
  - Anomaly Resolution
  - Engine Assembly/Maintenance
- Status
  - Engine installation into A-1
  - A-2 maintenance/modifications





# RS-68

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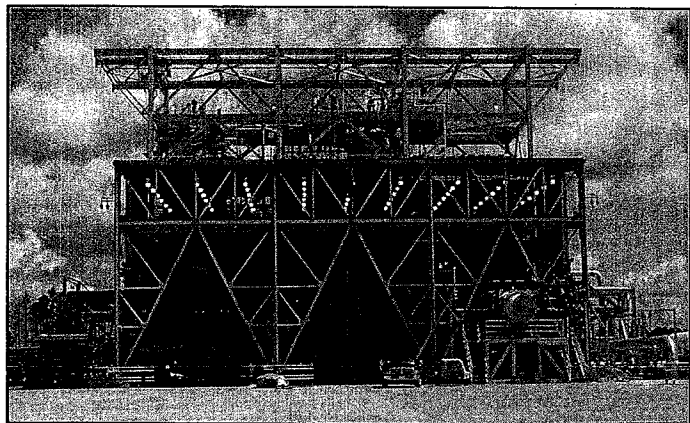


- Location
  - B-1 Test Position
- Scope
  - Development, Certification and Production Acceptance Testing
  - World-Class Assembly Facility at SSC
  - Two-position Test Stand
- Status
  - B-1 Dual Position Operational
  - 1st test on Position "B" - 9/8/99
  - 1st test on Position "A" - 11/6/99
  - 74 tests to date
  - Engine installation into position B in work



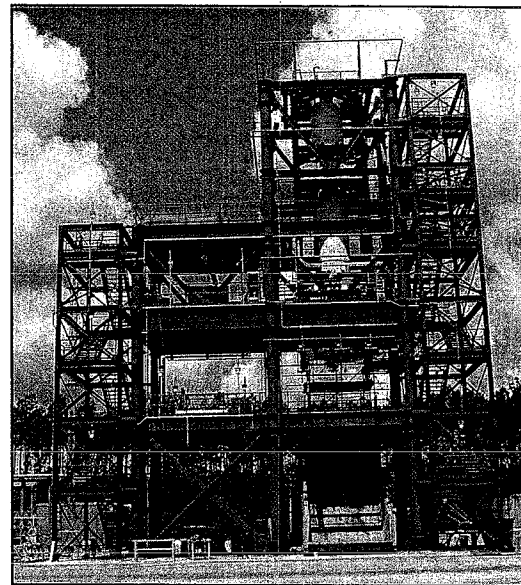
# E-Complex

*Stennis Space Center*

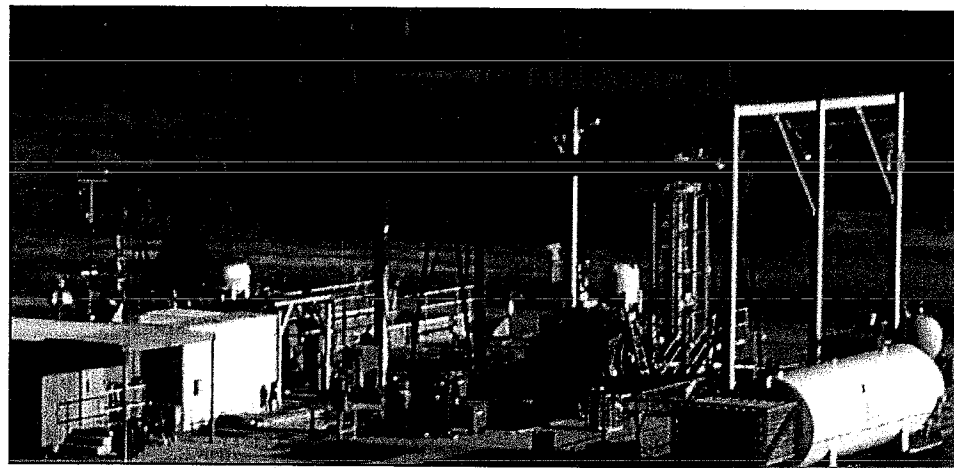


**E-1**

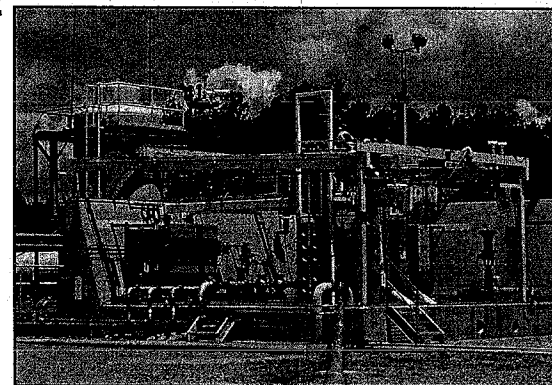
**Bartt J. Hebert**  
**Propulsion Test Directorate**  
**NASA, Stennis Space Center**



**E-2**



**E-3**



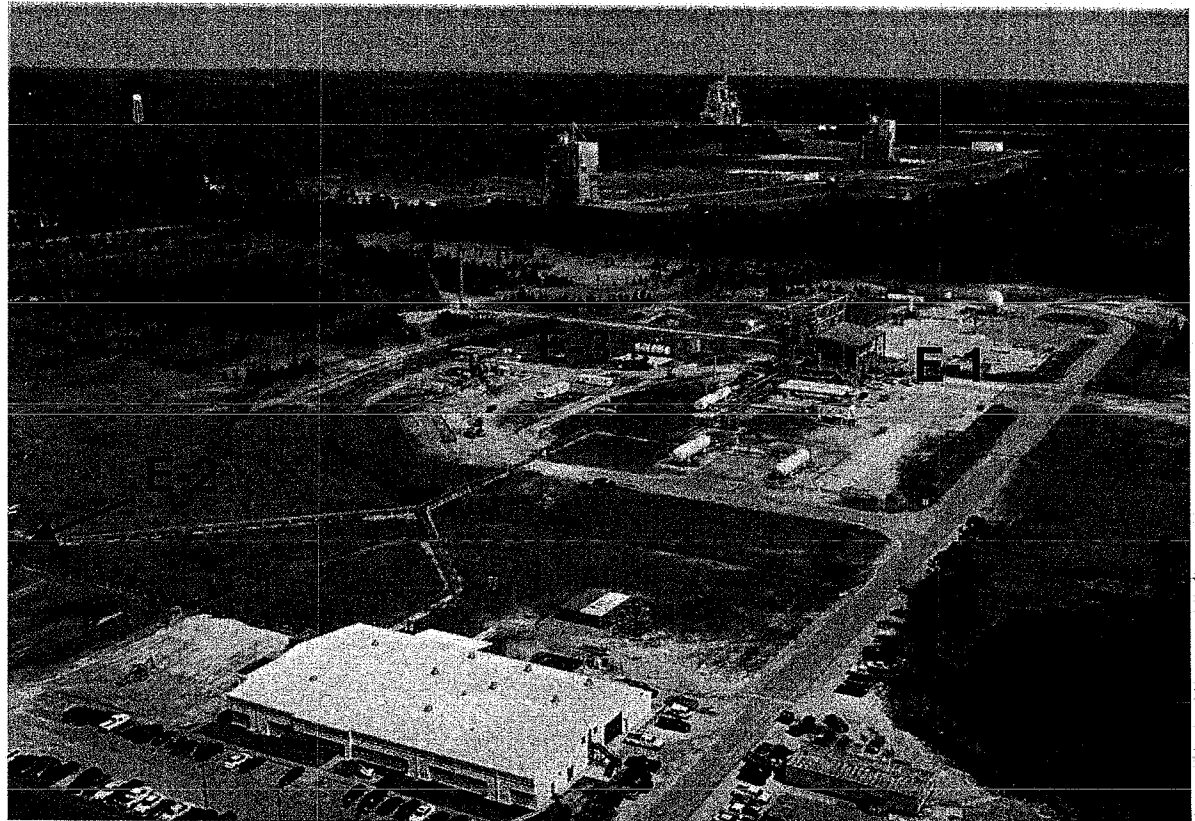




# E-Complex

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- E Complex Comprised of Three Test Stands
  - E-1 Having Three (3) Test Cells
  - E-2 Having Two (2) Test Cells
  - E-3 Having Two (2) Test Cells
- Versatile Test Complex
  - Thrust Chambers (sub-scale to full scale)
  - Turbopump Assemblies
  - Preburners
  - Engine Systems
- Multiple Propellants
- High Flow Rate Capabilities
- High Delivery Pressure Capabilities





# E-Complex History

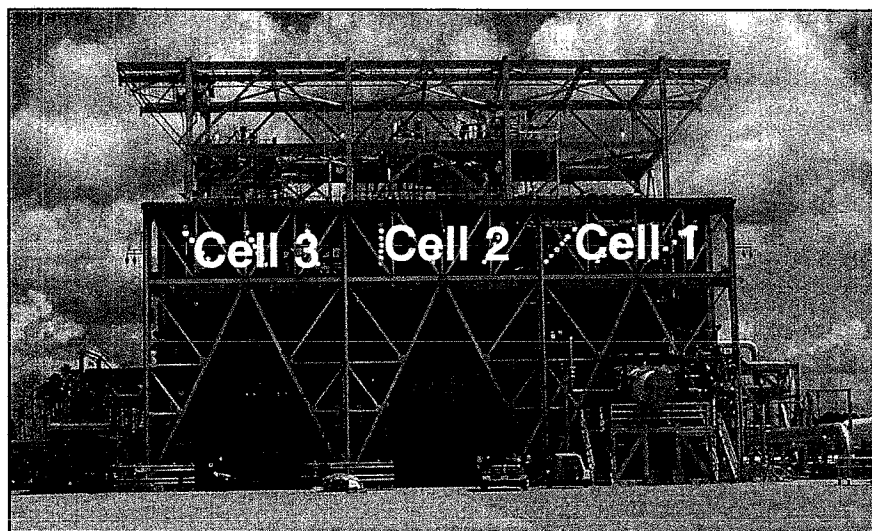
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- Late 1980s/Early 1990s
  - DoD/NASA Advanced Launch System and National Launch System
  - National Aerospace Plane
- Construction Starts
  - E-1 1989
  - E-2 1991
  - E-3 1995
- First Test
  - E-1 1999
  - E-2 1994
  - E-3 1995



# E-1 Test Stand Capabilities

Stennis Space Center



- General Pressure Capabilities

- $\text{LO}_2/\text{LH}_2 \sim 8,500$  psia
- Support Fluids  $\sim 15,000$  psia
- Support Systems: GHe, GN, GOX, Hydraulics, TEA/TEB

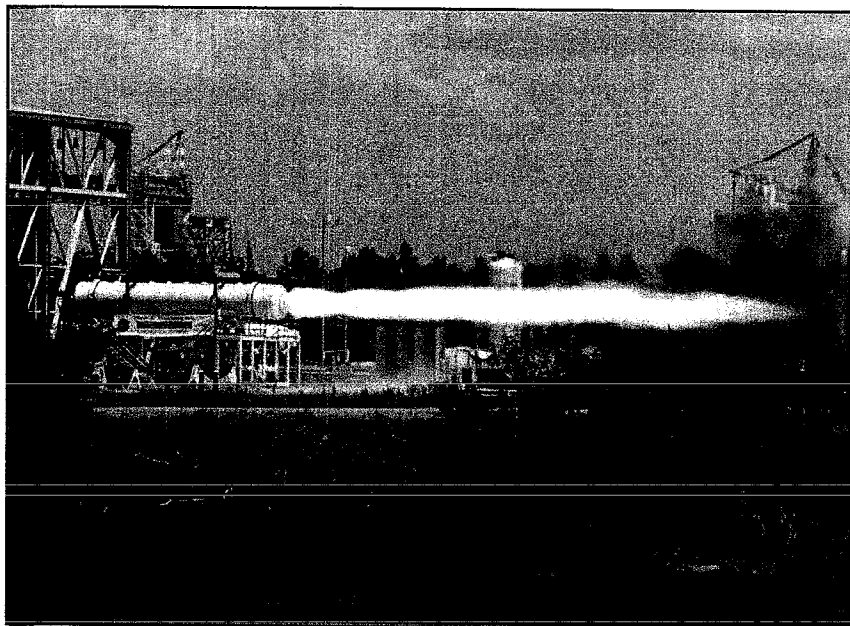
- E-1 Cell 1
  - Pressure-Fed  $\text{LO}_2/\text{LH}_2$  & Hybrid-Based Test Articles
  - Thrust Loads up to  $750\text{K lb}_f$  (horizontal)
- E-1 Cell 2
  - $\text{LH}_2$  Turbopump & Preburner Assembly Testing
  - Thrust Loads up to  $60\text{K lb}_f$
- E-1 Cell 3
  - $\text{LO}_2$  Turbopump & Preburner Assembly Testing
  - Thrust Loads up to  $60\text{K lb}_f$



# E-1 Test Stand Activities

Stennis Space Center

## 250K Hybrid Motor Program



- Conducted (4) Hotfire Test at E-1 Cell 1
- LO<sub>2</sub> Propellants
- Thrust ~ 250K lb<sub>f</sub>
- Phase 1 Testing Completed Late 1999 (3 tests)
- Phase 2 Testing Completed Early 2002 (1 test)
- Achieved 35 second Duration Steady State Test at Full Thrust



# E-1 Test Stand Activities

Stennis Space Center

## Ultra Low Cost Engine (ULCE) Program

- Conducted (15) Hotfire Tests at E-1 Cell 1
- Tested TRW, Inc. Pintle-Based ULCE at E1 Cell 1
- LO<sub>2</sub>/LH<sub>2</sub> Propellants
- Thrust ~ 650K lb<sub>f</sub>
- Testing Completed Late-2000
- Achieved 8 second Duration Steady State Test at Full Thrust

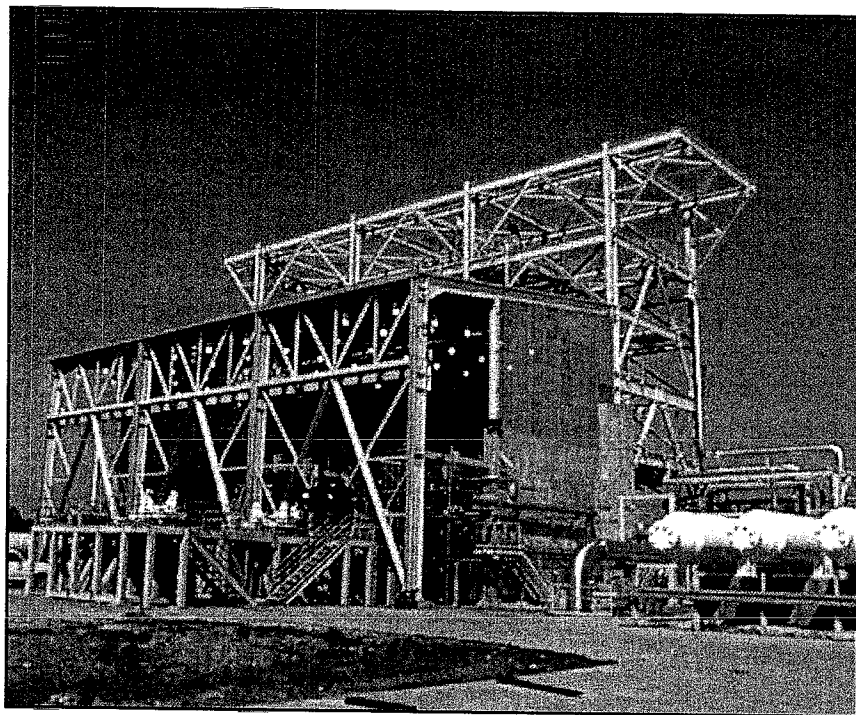
## Integrated Powerhead Demonstration (IPD) Program

- Joint NASA/Air Force Program
- Tested IPD LOX Turbopump at E-1 Cell 3
- HP GN Turbine Drive
- LP LN Feed
- Phase 1 Testing Completed Late-2001
- Achieved Steady State Test at 75% RPL



# E-1 Test Stand Upcoming Programs

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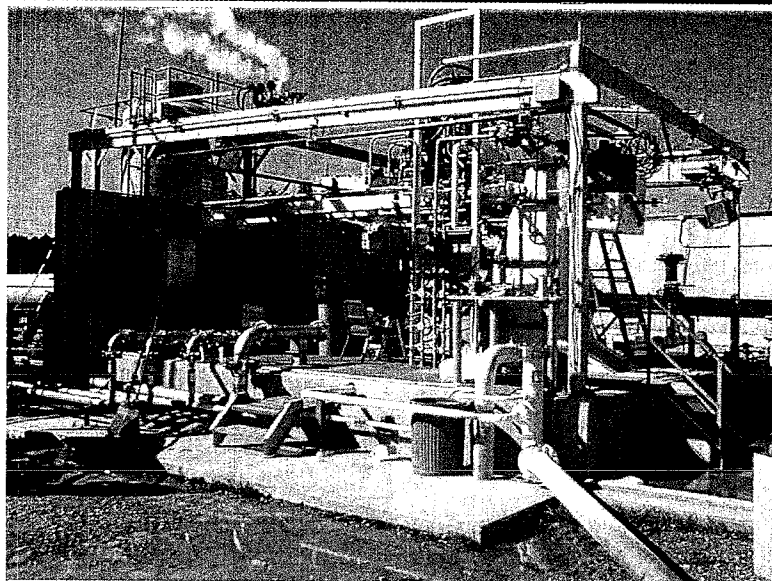


- Cell 1
  - Boeing RS-83 LOX/LH Preburner
  - Aerojet/P&W COBRA LOX/LH Preburner
- Cell 2
  - IPD LH Turbopump Test
  - IPD LH Turbopump Hotfire
  - IPD LH Fuel Rich Preburner
- Cell 3
  - IPD Ox-rich Preburner Test
  - IPD LOX Turbopump Hotfire
  - IPD Integrated System Test

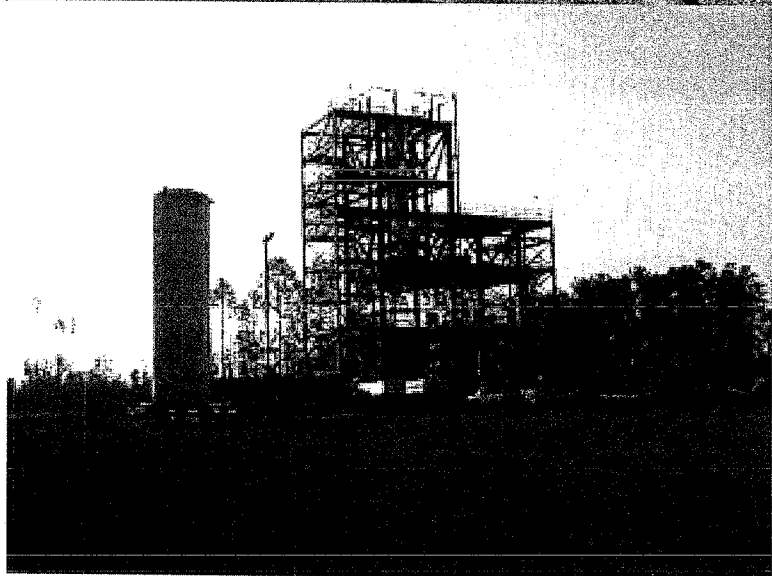


# E-2 Test Stand Capabilities

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- E2 Cell 1
  - Pressure-Fed  $\text{LO}_2$ /RP1 Based Test Articles
  - Thrust Loads up to 100K  $\text{lb}_f$  (horizontal)
  - $\text{LO}_2$ /RP-1 ~ 8,500 psia
  - GN/GH ~ 15,000 psia
  - Hot GH (1,300 F @ 6,000 psi)



- E2 Cell 2
  - $\text{LO}_2$  /RP-1 Engine/Stage Test Articles
  - Loads up to 150K  $\text{lb}_f$
- Support Systems
  - GHe, GN, Hydraulics



# E-2 Test Stand Activities

Stennis Space Center

## RS-76 LOX Rich Preburner Program

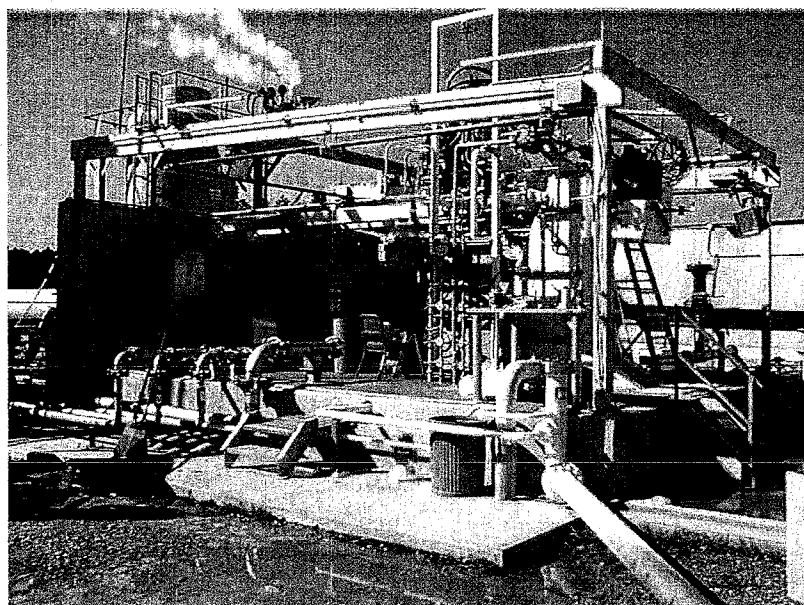
- Conducted Several Hotfire Test at E-2 Cell 1
- 7,000 psi LO<sub>2</sub>/RP-1 pressure fed
- Thrust ~ 30K lb<sub>f</sub>
- Testing Completed Early 1999
- Achieved 12 second Duration Steady State Test at Full Thrust





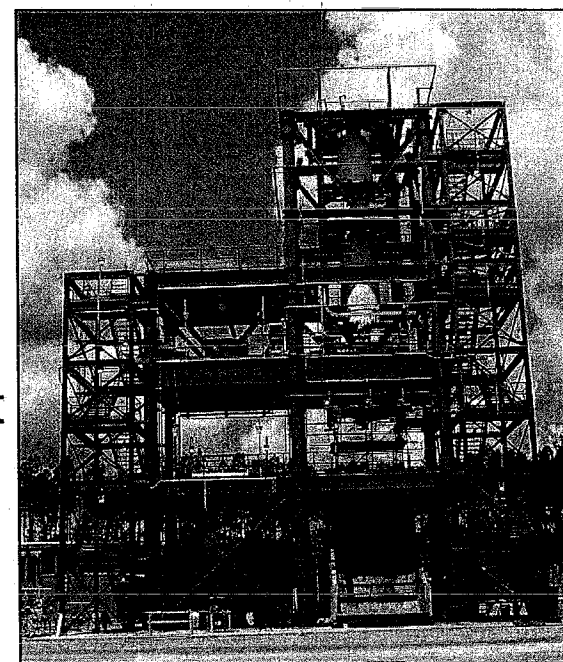
# E-2 Test Stand Upcoming Programs

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- Cell 1
  - Air Force LR-89 LOX/RP Pressure Fed 75 k-lb Thrust Chamber
  - Boeing RS-84 LOX/RP Sub-Scale Preburner and TCA

- Cell 2
  - Air Force/Orbital Upper Stage Flight Experiment ( $\text{H}_2\text{O}_2$ /JP-8)



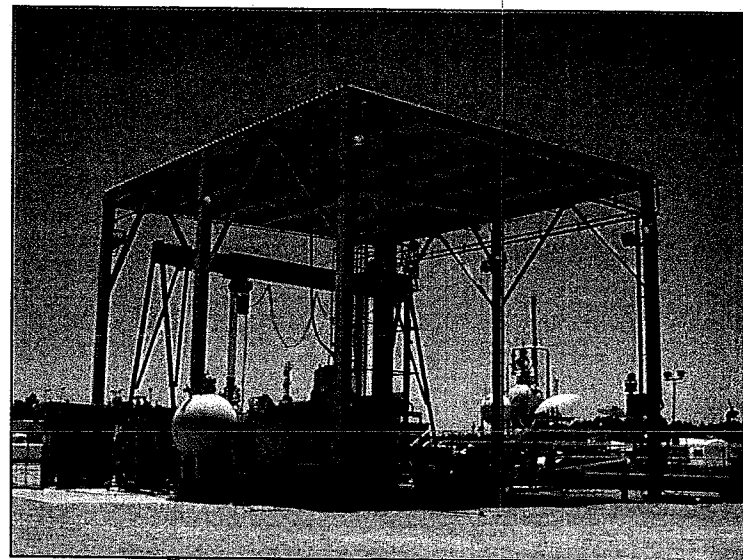


# E-3 Test Stand Capabilities

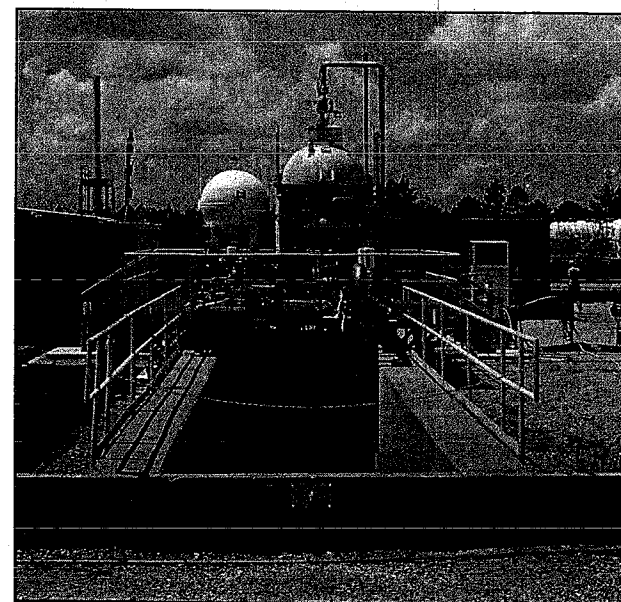
Stennis Space Center

- E3 Test Stand Capabilities
  - Rocket Engine Component & Sub-Scale Engine Development
  - Comprised of Two (2) Test Cells
- E3 Cell 1
  - Horizontal Testing
  - Propellants:  $\text{LO}_2$ ,  $\text{GOX}$ , Hydrocarbons,  $\text{GH}_2$
  - Support Systems:  $\text{LN}_2$ ,  $\text{GN}_2$ ,  $\text{GHe}$
  - Thrust Loads up to 60K  $\text{lb}_f$
- E3 Cell 2
  - Vertical Testing
  - Propellants:  $\text{LO}_2$ ,  $\text{H}_2\text{O}_2$ , Hydrocarbons
  - Support Systems :  $\text{LN}_2$ ,  $\text{GN}_2$ ,  $\text{GHe}$
  - Thrust Loads up to 25K  $\text{lb}_f$

Cell 1



Cell 2





# E-3 Cell 1 Test Stand Activities

Stennis Space Center

## Hybrid Sounding Rocket (HYSR)

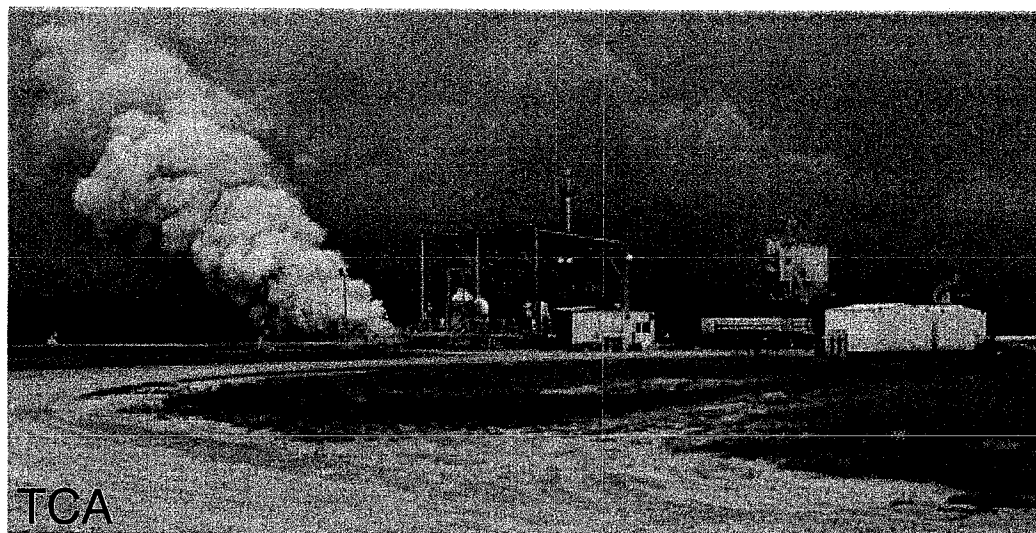
- Tested Lockheed Martin Michoud Space Systems HYSR at E-3 Cell 1
- HYSR Designed For Sub-Orbital & Atmospheric Science Missions
- LOX Fed Hybrid-Based Test Article
- Thrust ~ 60K lb<sub>f</sub>
- Achieved Steady State Test at Full Thrust



# E-3 Cell 2 Test Stand Activities

Stennis Space Center

## Hydrogen Peroxide Programs (85% to 98%)



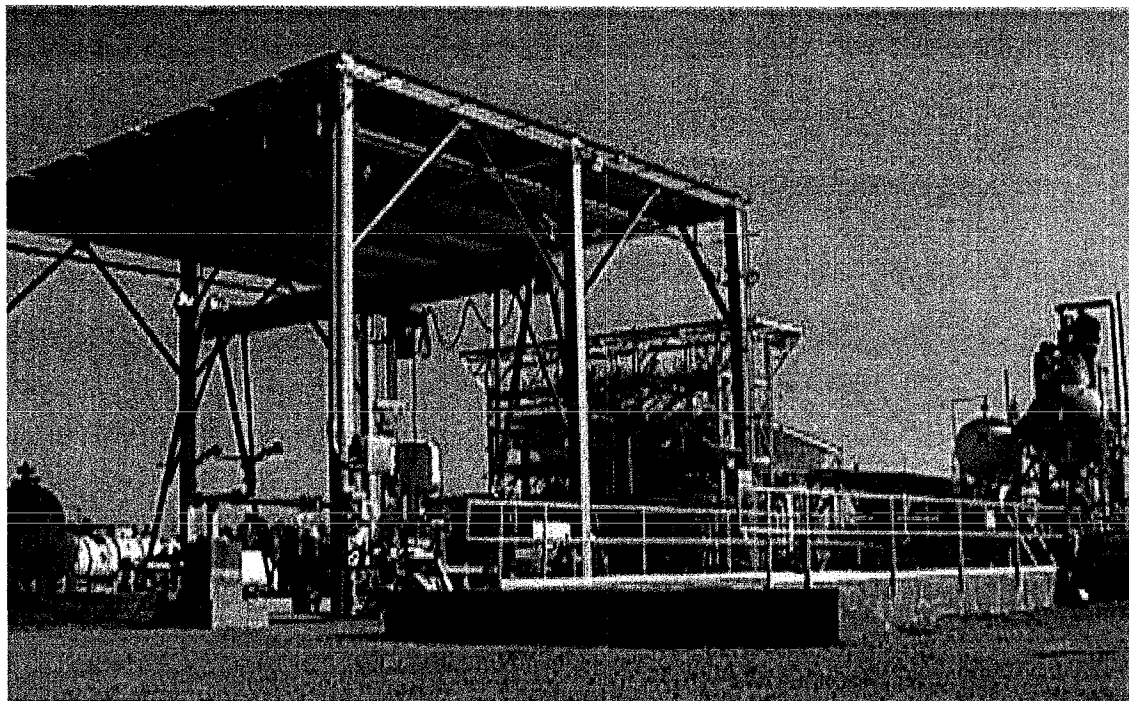
- Tested Several  $\text{H}_2\text{O}_2$  Test Articles
  - Boeing AR2-3
  - Orbital Sciences Corporation TCA
  - Pratt & Whitney and Boeing Catalyst Bed Testing Programs



# E3 Test Stand Upcoming Programs

*Stennis Space Center*

- Cell 1
  - $\text{H}_2\text{O}_2$ /JP Turbopump Development

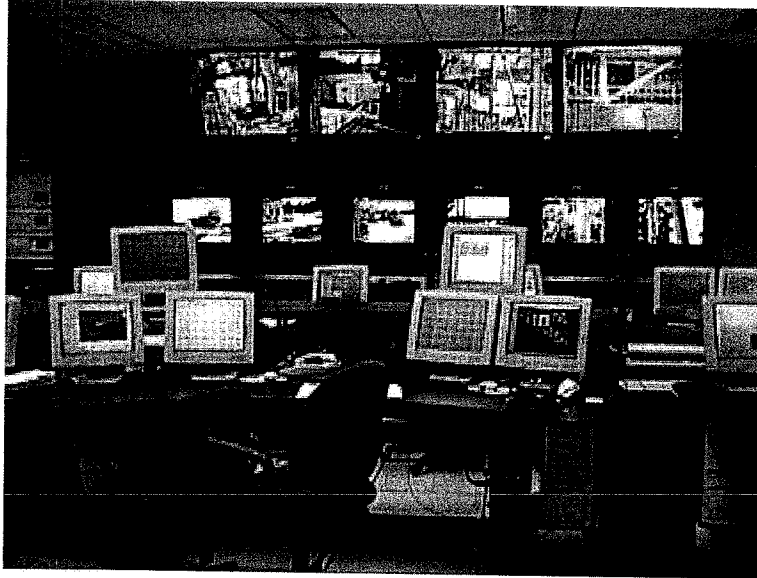


- Cell 2
  - $\text{H}_2\text{O}_2$ /JP Thrust Chamber Development



# E-Complex Control Rooms

*Stennis Space Center*



E-1 Control Room



E-2 Control Room



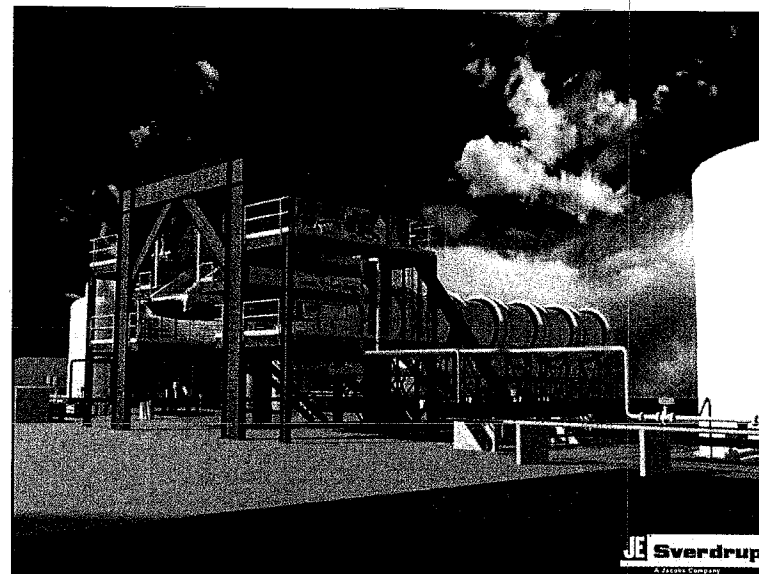
E-3 Control Room



# E-4 Future Test Stand

*Stennis Space Center*

- Designed for Testing of RBCC Engine Systems and Powerpack Assemblies
  - 50 K Thrust Capability
  - Low Pressure JP-7 and H<sub>2</sub>O<sub>2</sub> Propellant Supply
- Single-Cell Test Stand
- Facility Construction Complete 6/04/04
- Facility Activation/Checkout Complete 2/07/05



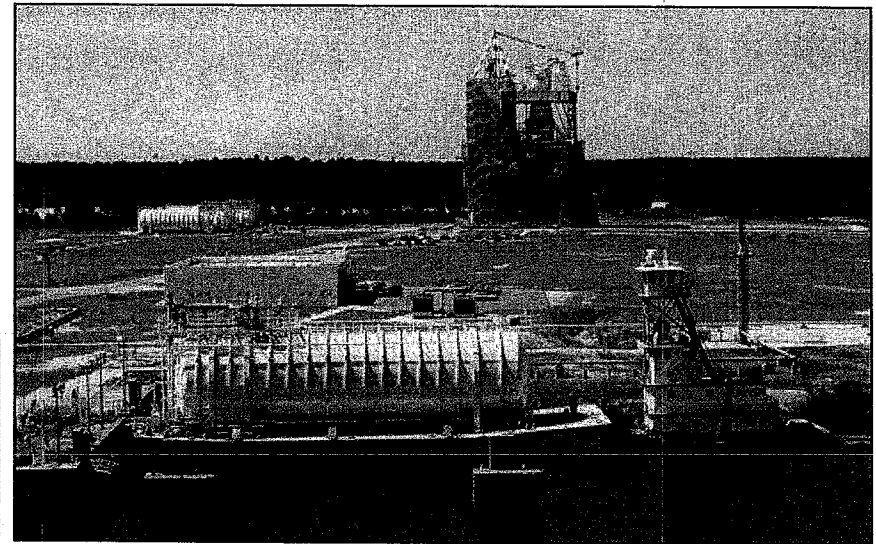




# SSC Propulsion Test Support Services

*Stennis Space Center*

**Stan Gill**  
**Propulsion Test Directorate**  
**NASA, Stennis Space Center**







# SSC Test Support Services

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*Stennis Space Center*

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- SSC has all the required functions along with some unique support facilities to support propulsion testing.
  - High Pressure Gas Facility
  - High Pressure Industrial Water
  - Cryogenic Propellant Storage/Transfer Facility
  - Laboratories
  - Shops
  - Utilities
  - Other Services



# High Pressure Gas Facility (HPGF)

*Stennis Space Center*

- Helium System

- > Max Pressure 4,500 psig
- > 2 Storage Vessels - each 10,000 ft<sup>3</sup>
- > Max hydrocarbon content - 10 ppm

- Hydrogen System

- > Max Pressure 3,000 psig
- > 1 Storage Vessel – 20,000 gal

- High Pressure Air System

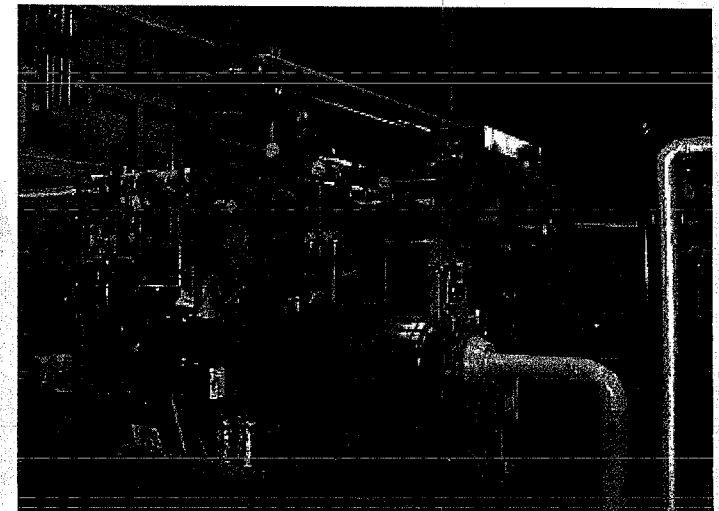
- > Max Pressure 2,800 psig
- > Missile grade air

- Nitrogen System

- > Max Pressure 4,400 psig
- > 2 Storage Vessels – 63,250 gal and 27,000 gal

- Auxiliary Tube Bank Storage

- > 7 Helium Trailers
- > 7 Nitrogen Trailers
- > 2 Hydrogen Trailers

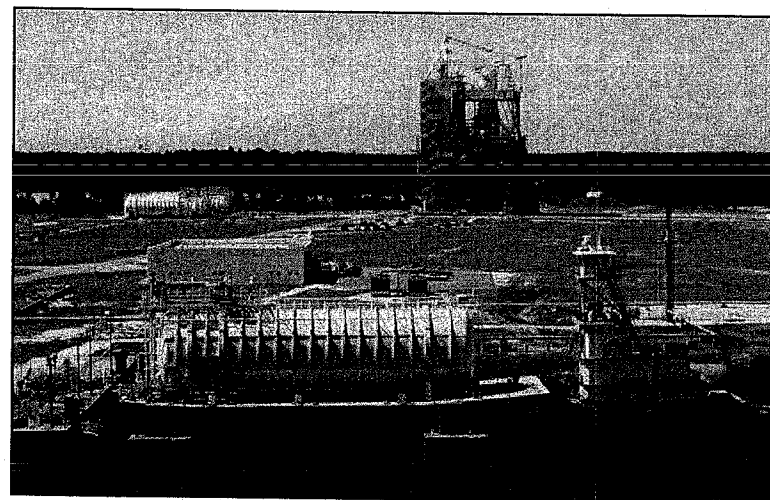
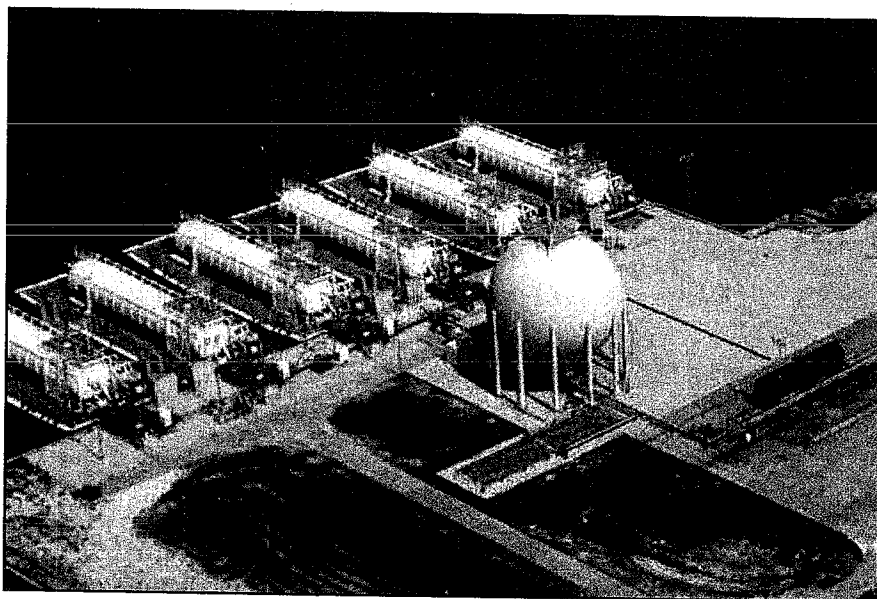




# Cryogenic Propellant Storage Facility

*Stennis Space Center*

- Six LOX Barges – 97,500 gallons each
- Three LH<sub>2</sub> Barges – 250,000 gallons each
- Propellant storage/transfer facility (trailers and barge)
- Integrated canal system for barge traffic
- Control panels for barge systems checkout
- Real-time transfer capability on vertical test stands

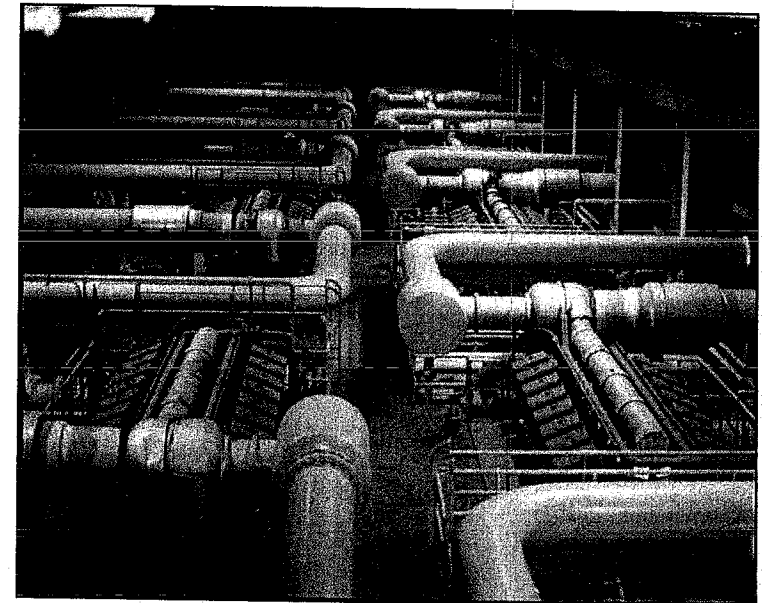
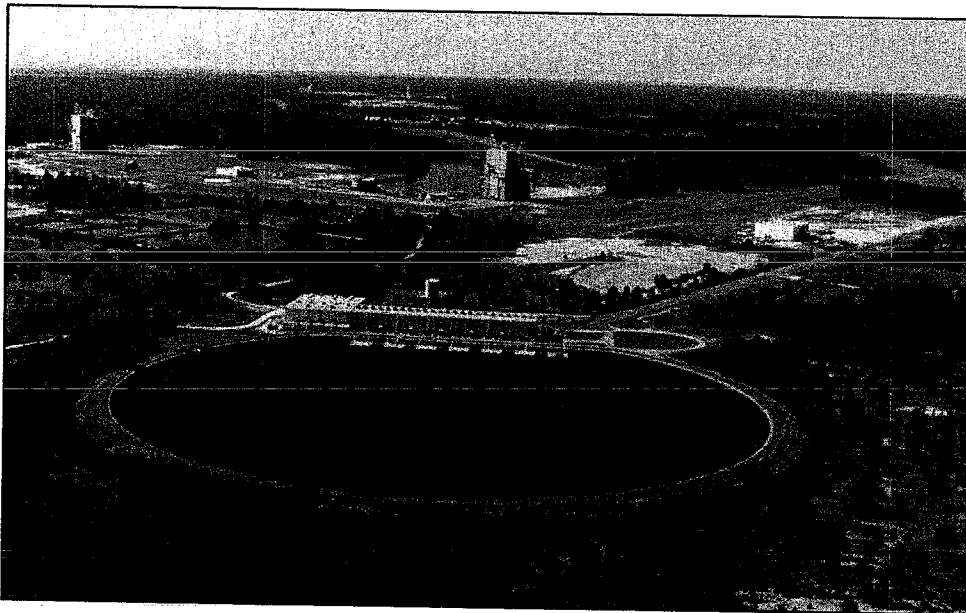




# High Pressure Industrial Water (HPIW)

*Stennis Space Center*

- 66,000,000-gal reservoir with industrial wells
- Ten diesel-driven pumps with a total capacity of 330,000 gal/min for a duration of 40 min.
- Piping and foundation to expand to 13 pumps
- Deluge and cooling water is provided to A-1, A-2, and B-1/B-2





# Bascule Bridge & Lock

*Stennis Space Center*



4/16/02



# Laboratories

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*Stennis Space Center*

- Environmental
- Gas and Material Analysis
- Measurement Standards and Calibration



# **Shops**

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*Stennis Space Center*

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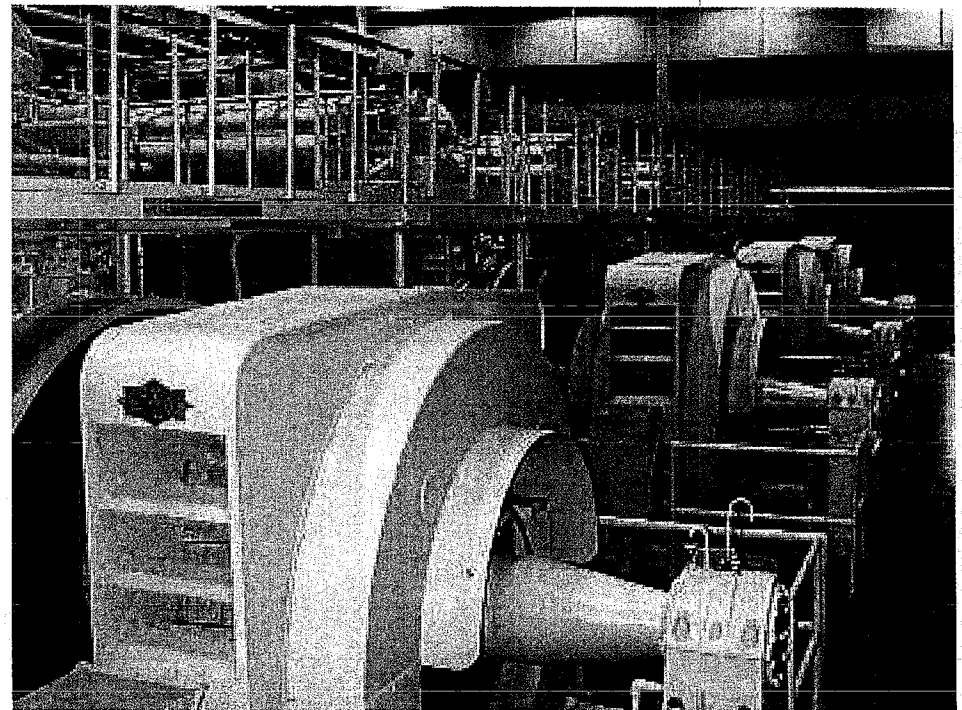
- Carpentry Shop
- Mechanical/Plumbing Shop
- Electric Shop
- Heating, Ventilation, and Air-Conditioning Shop
- Paint Shop
- Weld/Fabrication Shop
- Machine Shop
- Component Support
- Nondestructive Test and Evaluation Laboratory



# Utilities

*Stennis Space Center*

- Electric
  - (2) 13.8 kilovolt feeds to SSC
  - Emergency generators
  - (4) 1,875 KVA, diesel-driven generators
  - Located in the HPIW Facility
  - Supports A/B Complex activities



Four Diesel-Driven Generators at HPIW





# Other Services

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*Stennis Space Center*

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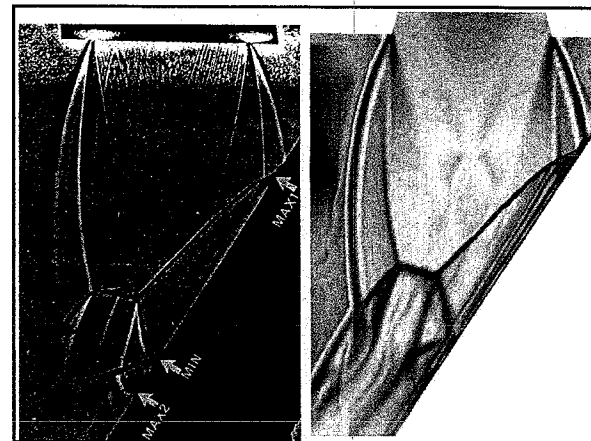
- Medical Clinic/Emergency Response Team
- Wellness/Fitness Facility
- Food Services
- Recreational Association
- Fire Department
- Security Services
- IT Support



# Engineering and Test Technology

Stennis Space Center

**S. A. Rahman**  
**Engineering Division**  
Propulsion Test Directorate  
NASA, Stennis Space Center



*Technology*



*Design*

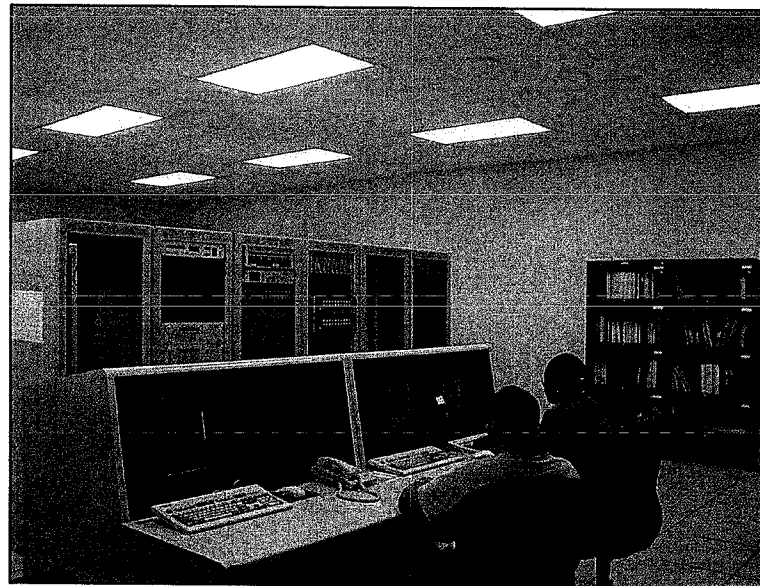


# Engineering: Primary Responsibilities

*Stennis Space Center*

- Test Systems Mechanical Design
- Test Systems Electrical Design
- Technology for Safety & Operability

**Turning Test Requirements  
into Test Systems**



*DACS System Development*



# Engineering of Test Systems

Stennis Space Center

- **Mechanical Test Systems**

- Propellant Supply for Oxidizer, Fuel
- Ignition, Purges, Thrust Mounts
- Supporting Analyses (static/dynamic flow pressure, structural, thermal)

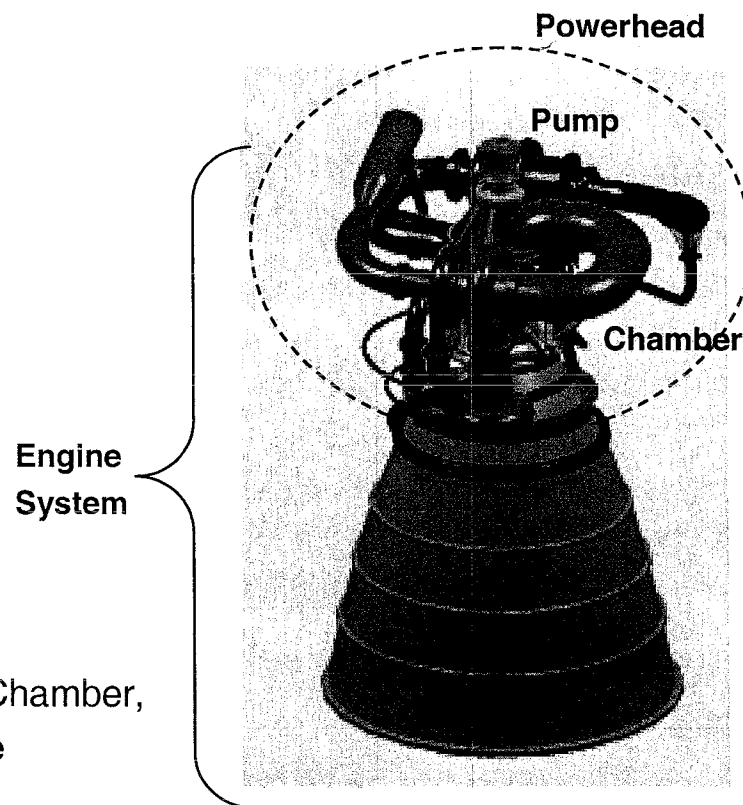
Design – a Systematic way of Mitigating Technical Risk

- **Electrical Test Systems**

- Instrumentation
- Controls
- Low-speed and High-speed Data Acquisition
- Data Processing algorithms
- Ancillary: Video, Power, Gas & Fire Detection

## Test Articles

Pump, Preburner, Thrust Chamber, Powerhead, Engine, Stage



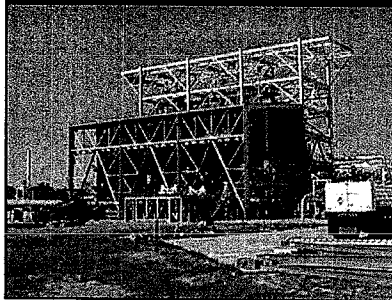
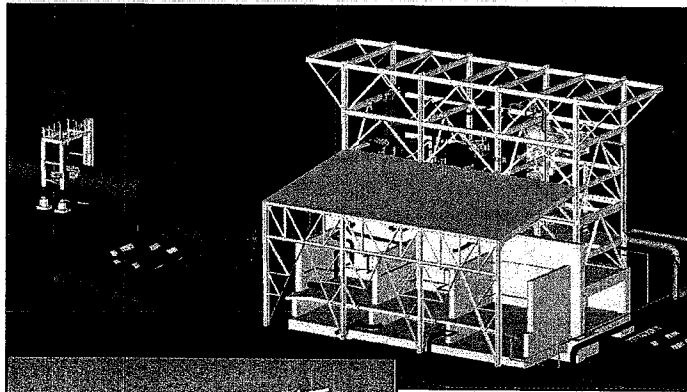


# Design and Analysis

Configuration Control

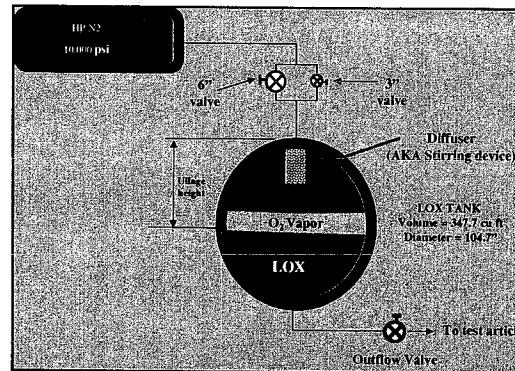
Stennis Space Center

## Computer Aided Design



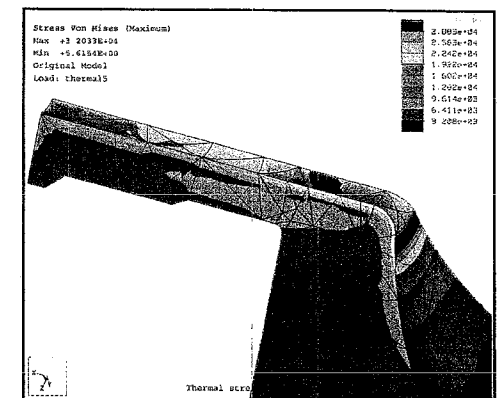
*E-1 Stand*

End-to-End Mechanical & Electrical Engineering Capability

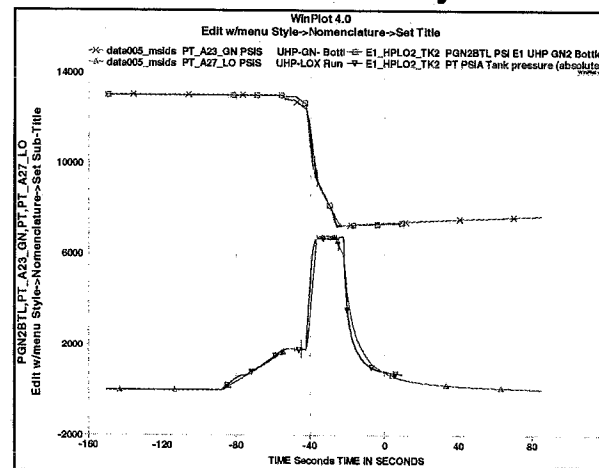
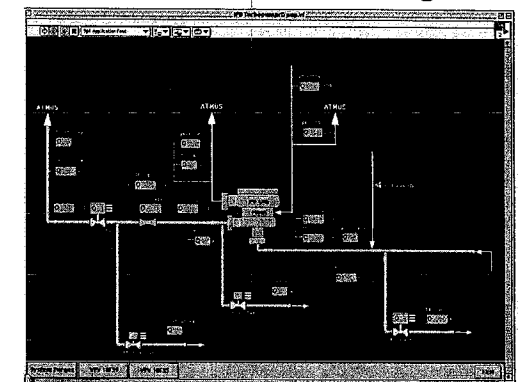


Steady-State & Transient Fluid-Thermo. Analysis

## Finite Element Analysis



## Controls/DAS Design

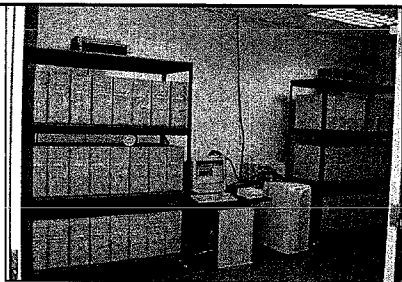
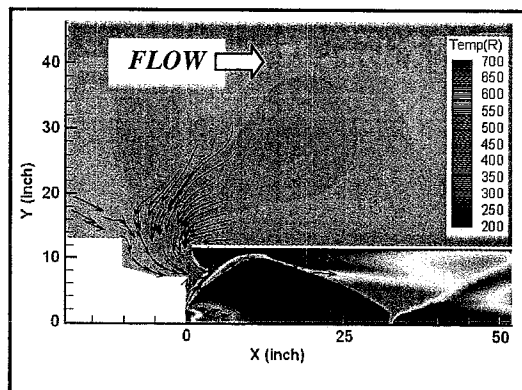




# Test Technology

Stennis Space Center

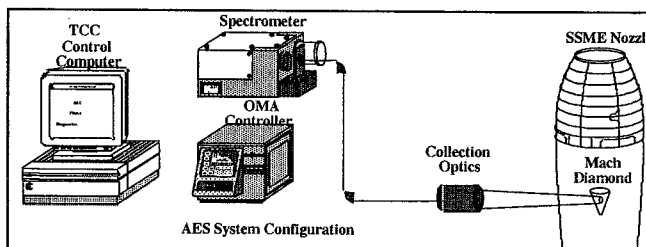
## Computational Fluid Dynamics



*PC-Cluster "Super Computer"*

Applying State-of-the-Art Technology  
To Support Test Projects & Enhance Safety

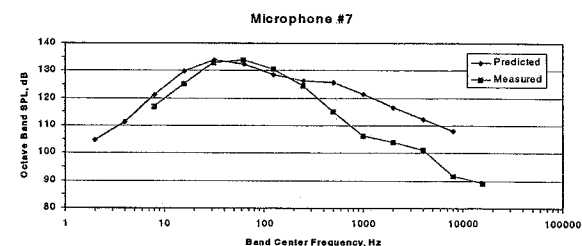
## Plume Spectroscopy



### Plume Diagnostics Instrumentation

Custom spectral analysis systems can detect minute levels of metallic contaminants indicative of abnormal engine wear

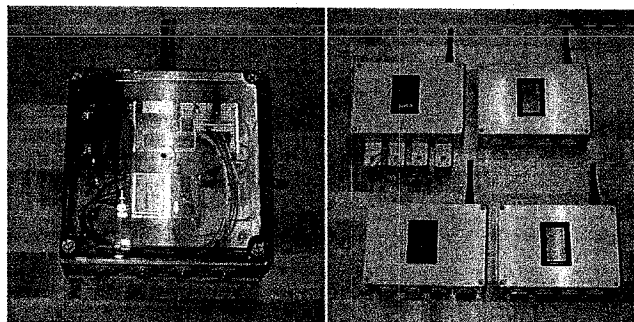
## Acoustic Data & Modeling



### 250K Hybrid (9-9-99)



## Wireless Sensors



*Wireless Thermocouples*

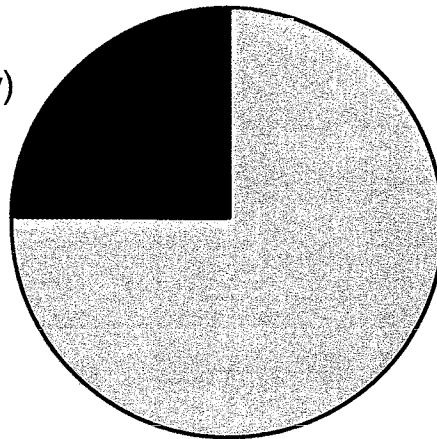
Affiliations with Government  
Technologists, University  
Experts, & NASA Technology  
Transfer programs



# Engineering Workforce & Skills Mix

*Stennis Space Center*

20 NASA Engineers  
(Design/Analysis/Technology)

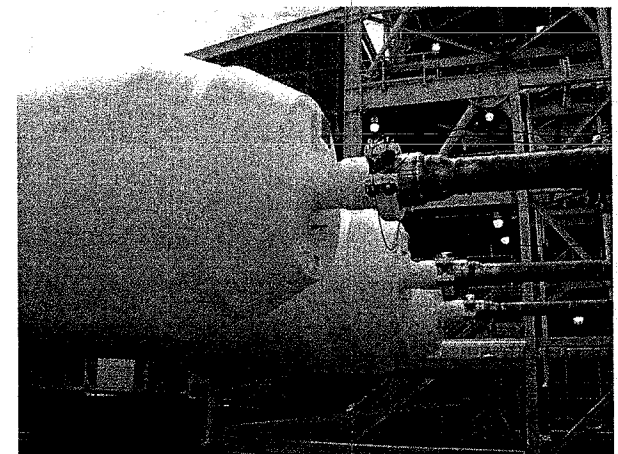


**A Diverse Skills Base within a  
Highly Experienced Workforce**

60 Contractor Engineers  
(Design/Analysis/Technology)

## Skill Areas

- Mechanical Components & Systems Design
- Fluid and Thermodynamic Analyses
- Cryogenic Engineering
- Pressure Vessel Design & Maintenance
- Instrumentation Systems & Special Sensors
- High-Speed/Low-Speed Data Acquisition Systems
- Materials Compatibility ( $O_2$ ,  $H_2$ ,  $RP$  &  $H_2O_2$ )
- Plume Effects Predictions, Measurements, & Diagnostics





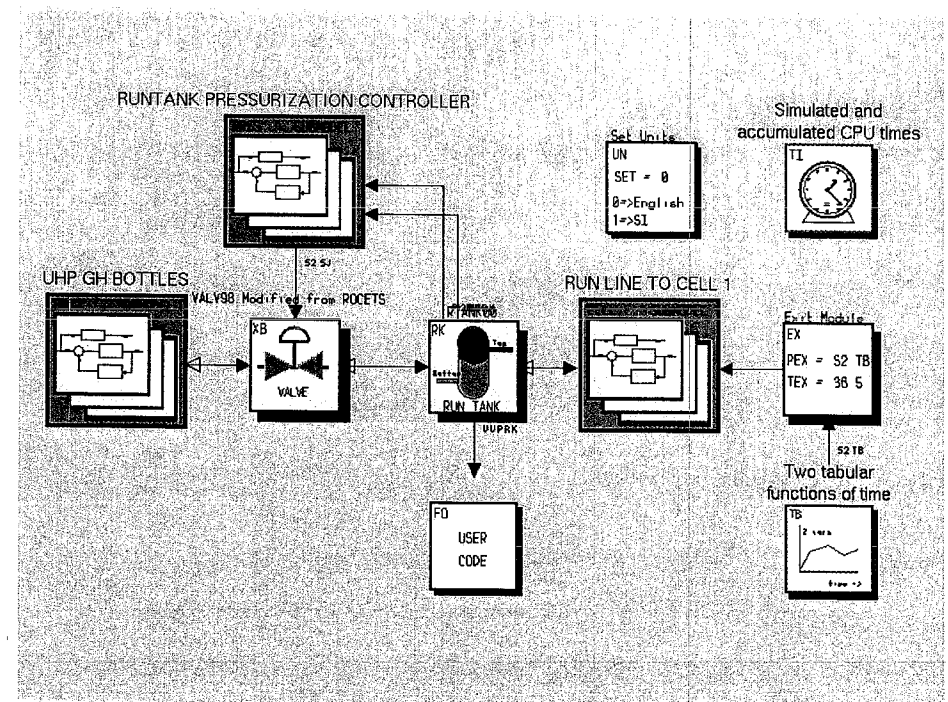
# Engineering Tools

Stennis Space Center

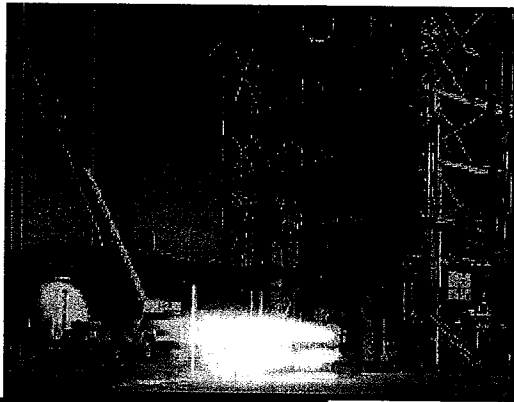
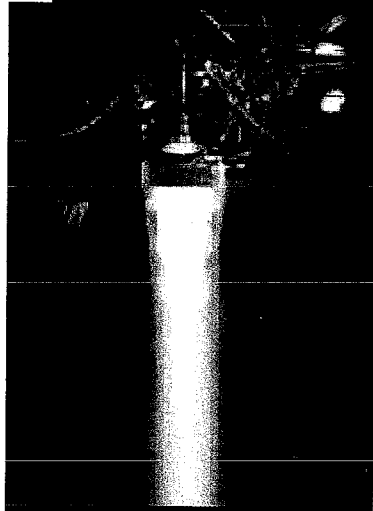
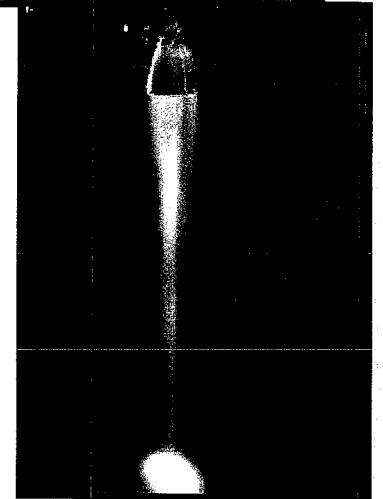
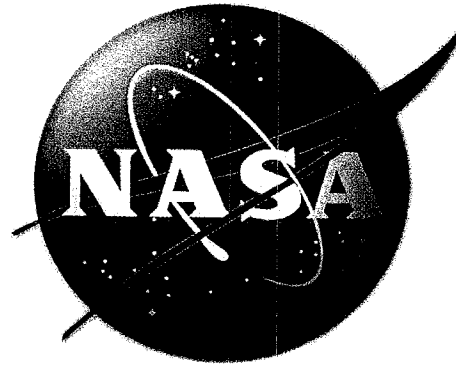
## Industry Standard & Custom Methods

The Right Tools to Model, Predict & Enhance Test Capabilities

- Pro/Engineer (CAD) & Pro/Mechanica (Analysis)
- ROCETS Code (Rocket Engine Transients Simulation)
- Fanno Flow Code
- NIST properties for real Fluids
- ALGOR Pipeplus
- FDNS (Finite Difference Navier Stokes)
- PLIMP (Plume Impingement)

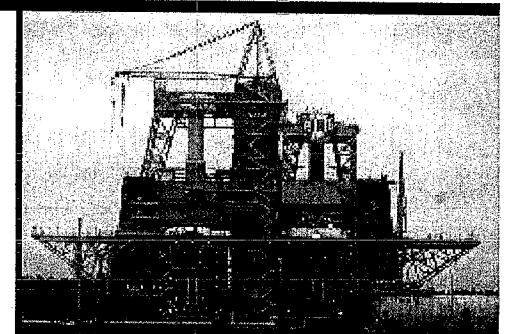
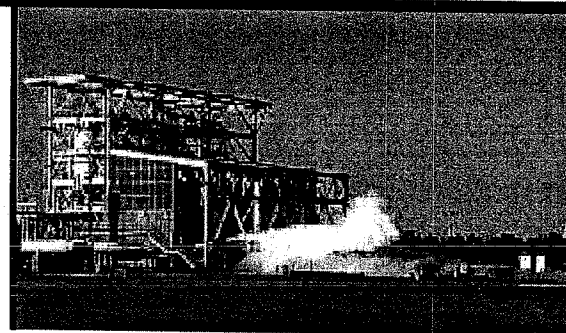


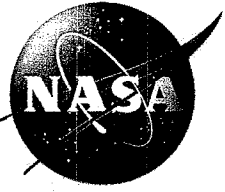




# *Stennis Space Center Propulsion Test Program Office*

April 16, 2002





# *Propulsion Test Program Office Responsibilities*

*Stennis Space Center*



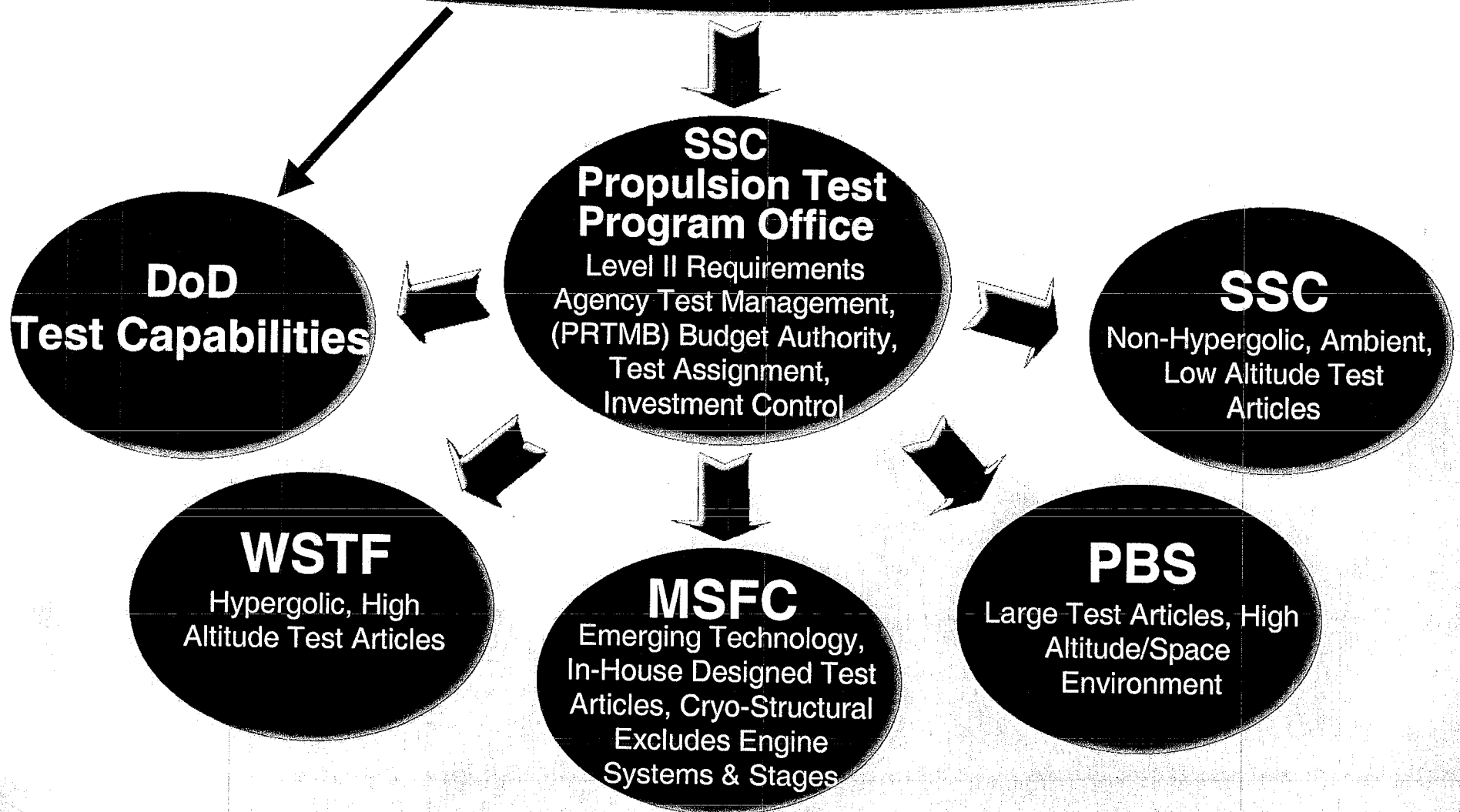
- Manage NASA's rocket propulsion test assets, activities, resources
- Develop testing and facility investments and consolidation strategies
- Set world-class standards for effectiveness and efficiency
- Determine where tests are performed
- Provide full customer services to other Gov. agencies and industry
- Develop and implement advances in test technology
- Improve cooperation with DoD rocket testing

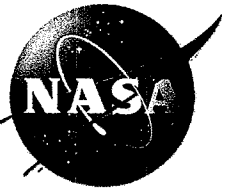


# *Propulsion Test Concept*

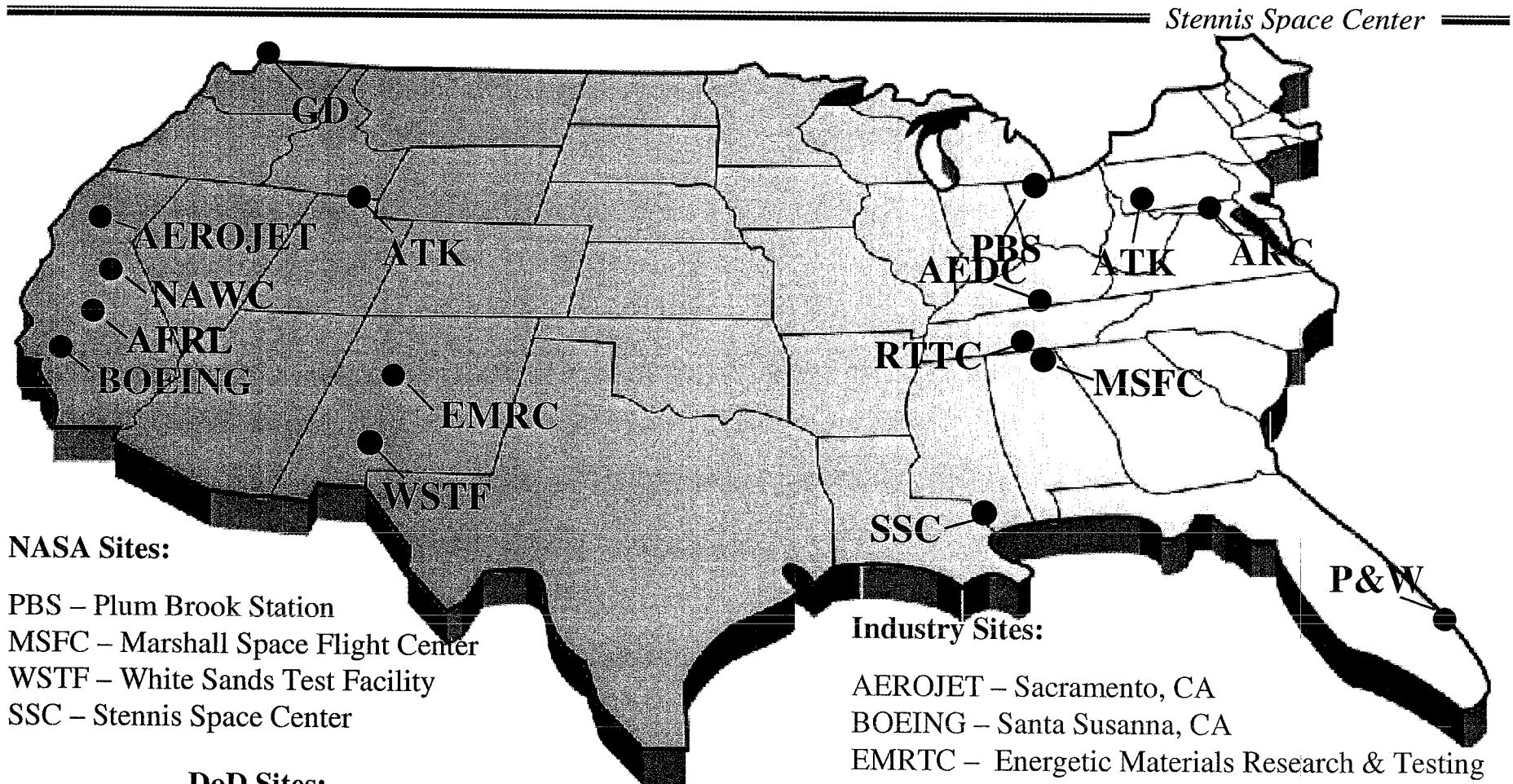


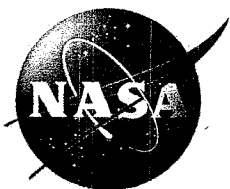
Propulsion Community Customer Requirements and Resources



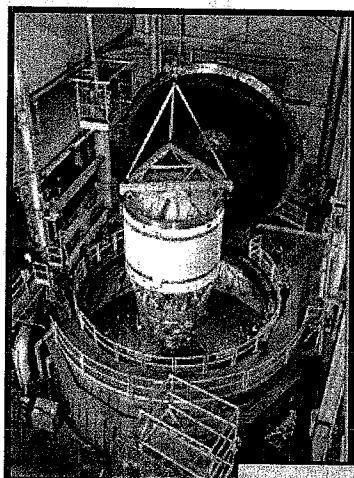


## Nation's Rocket Test Locations



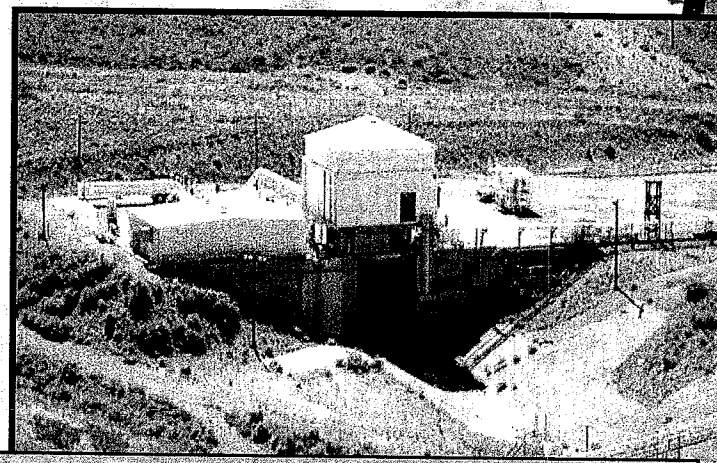


# Summary of NASA's Rocket Test Infrastructure



PBS

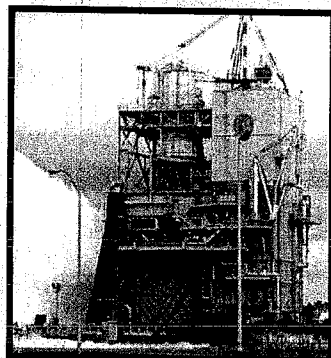
WSTF



	Current Facility Inventory			
	TOTAL	Active	Inactive	Mothballed
	32	26	3	3
SSC	12	11	0	1
GRC/PBS	1	1	0	0
MSFC	10	7	1	2
WSTF	9	5	0	4

	Removed From Inventory (to date)			
	TOTAL	Abandoned	Demolished	Non Rocket
	11	5	2	4
	1	0	0	1
	2	2	0	0
	7	3	2	2
	1	0	0	1

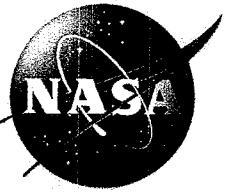
Current Replacement Value = ~ \$2B



SSC

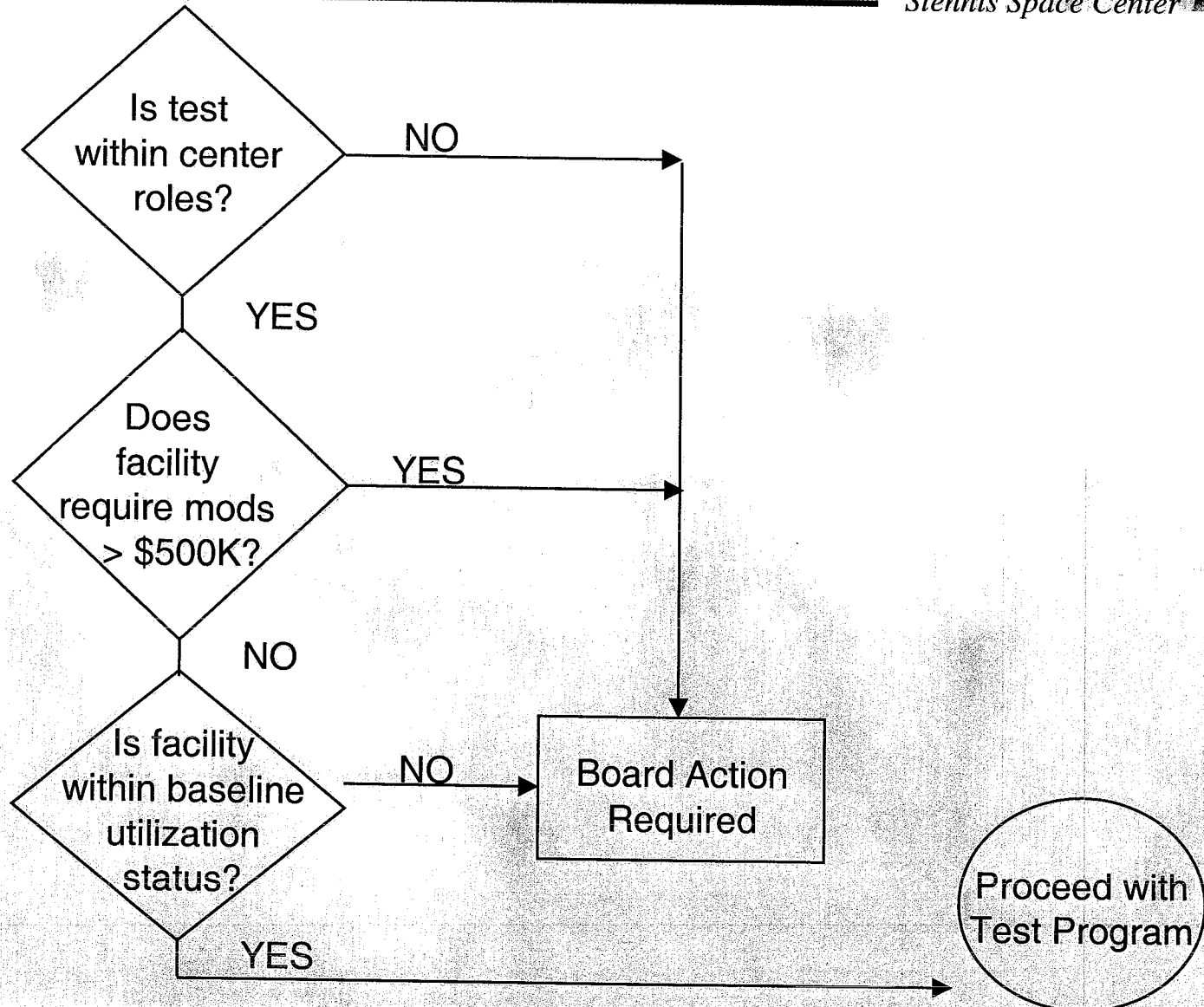
MSFC



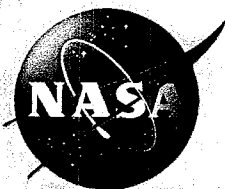


# RPTMB Process Flow

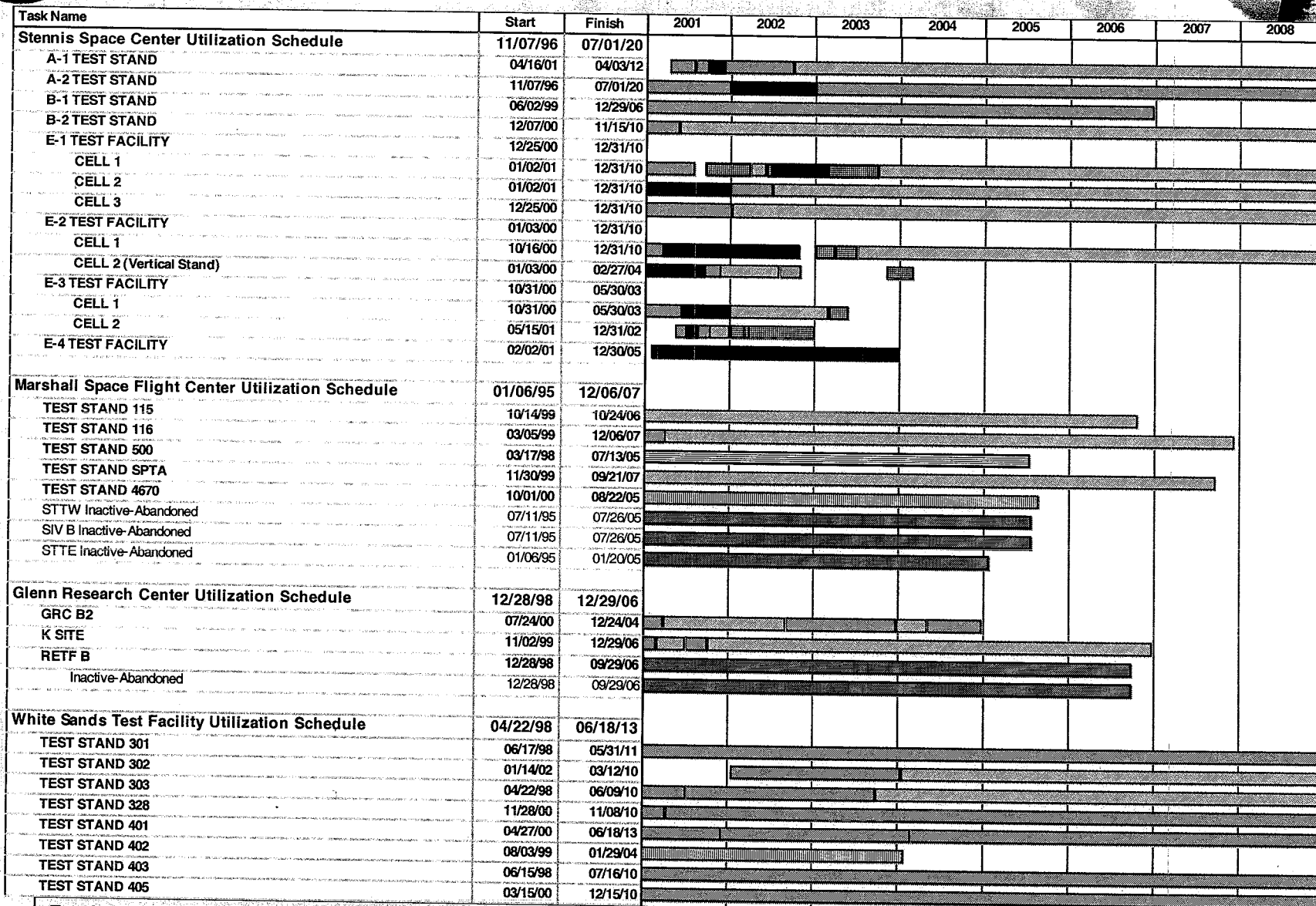
Stennis Space Center







# NASA Facilities Utilization Schedule (sample)



Test Stand Active Project



Pending Project



Inactive-Mothballed



Inactive for Rocket Hot Fire



Inactive-Available

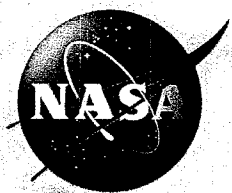


Under Construction/Activation

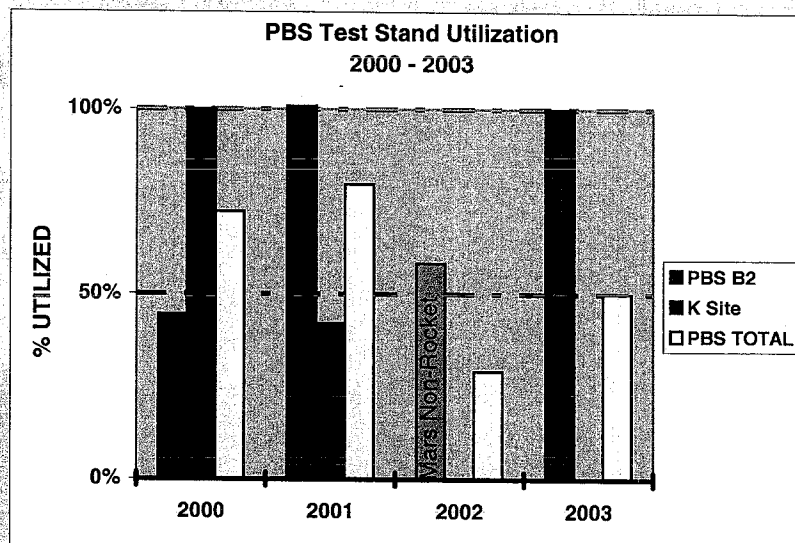
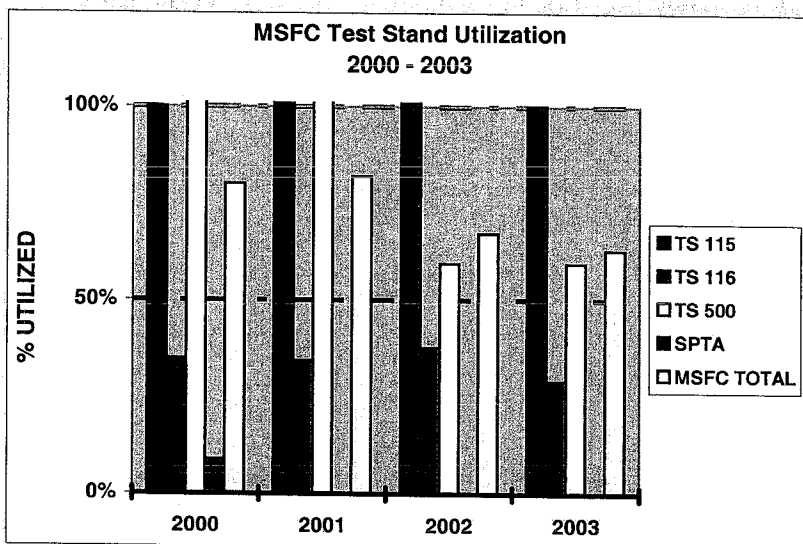
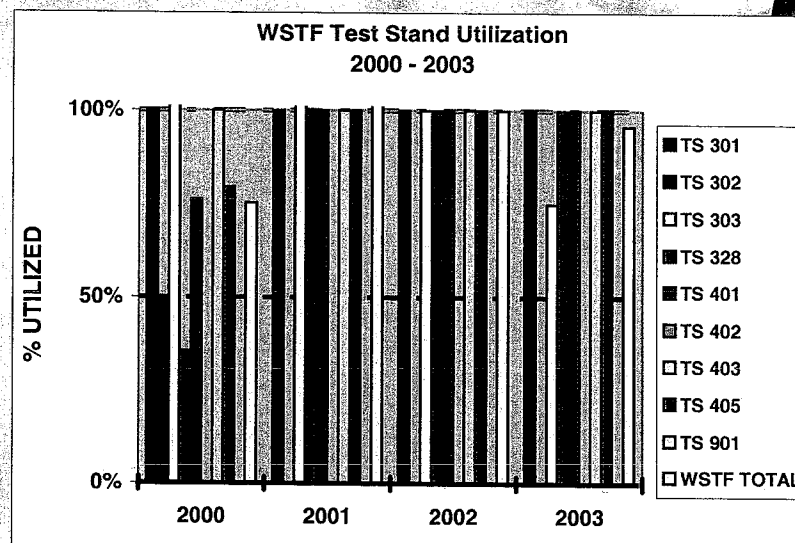
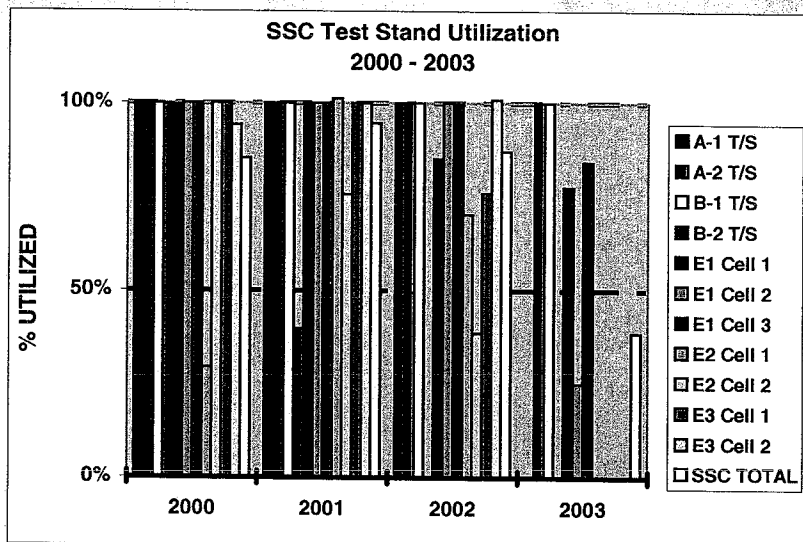


Inactive-Abandoned



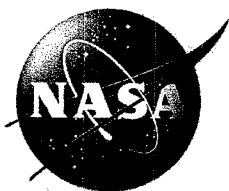


# NASA Test Stand Utilization\*



\* NOTE: Active/Inactive/Mothballed Test Stands Included. Based on 360 days in the year. Test Stands are equally weighted toward Site Total. Inactive, Mothballed Test Stands require some level of investment to re-activate.





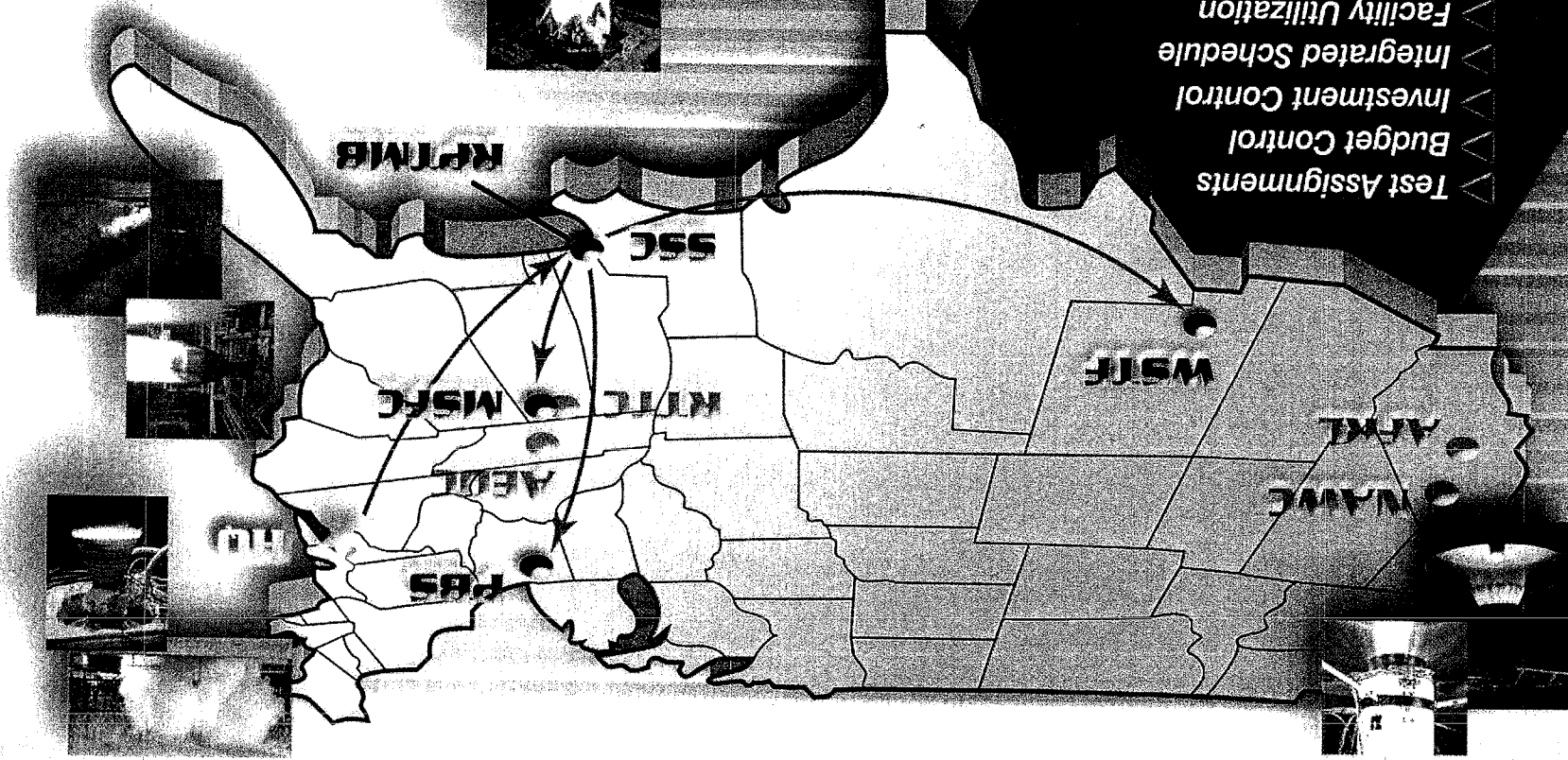
# Test Stand Capabilities Database (sample)



Site	Test Stand	Cell Name	Max Thrust	Altitude	Test Article	Diffuser	Status	Condition	Propellant	Volume	Pressure
AEDC	J-2A	J-2A	20	450	32 x 18	220	Abandoned	Poor			
AEDC	J-6	J-6	1500	100	62 x 26	240	Active	Excellent	Solid	1	1
AEDC	J-5	J-5	300	100	50 x 16	102	Mothballed	Excellent	Solid	1	1
AEDC	J-4	J-4	1500	100	125 x 48	480	Inactive	Excellent	A50	0.35	750
									LH2	10	250
									LOX	4	250
									Hydrazines	0.35	750
									N2O4	0.35	750
									N2H4	0.35	750
AFRL	-650130.0417	-650130.0417	1800	Ambient	12 x 18	N/A	Active	Excellent	LOX	75	150
									Hydrazines	28	165
									Hydrazines	58	35
									RP-1	60	150
AFRL	1-120 1B	1-120 1B	6000	Ambient	12 x 18	N/A	Mothballed		LOX	75	150
									LOX	750	15
									RP-1	65	150
MSFC	TF116	TF116 (750K)	100	Ambient	3 x 10	N/A	Inactive	Poor	GH2	1.25 ft3	15000
									GN2	1.25 ft3	10000
									GN2	0.70 ft3	8000
									LCH4/LH2	2	8500
									LOX	3	6000
MSFC	TF115	TF115	4	Ambient	3 x 3	N/A	Active	Good	GH2	20 ft3	3800
									LH2	2.2	1500
									LOX	0.5	3000

# Rocket Propulsion Test Management Board

**\$71M Savings / 92 Test Assignments**



Test Assignments  
Budget Control  
Investment Control  
Integrated Schedule  
Facility Utilization  
Facility Capability  
Industry Involvement  
Best Practices  
Consistent Processes



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*Stennis Space Center*

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**Welcome  
to the  
NASA John C. Stennis Space Center  
Propulsion Test  
Customer Day 2002  
(Day 2)**



# Doing Business with SSC

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*Stennis Space Center*

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- How to contact us
- SSC's evaluation process of your request
  - Does it fit
  - Specific Concerns
  - Type of agreement
  - Estimated (ROM) Cost
- Establishing the project / Project Formulation
  - Requirements by customer
  - Cost estimate and milestone schedule
  - Letter of commitment
  - Rough draft of agreements
- Project Management Activities
  - Single point of contact
  - Detailed requirements
  - Detailed schedules
  - Project Control
- Customer Feedback Opportunities



# How to Contact SSC

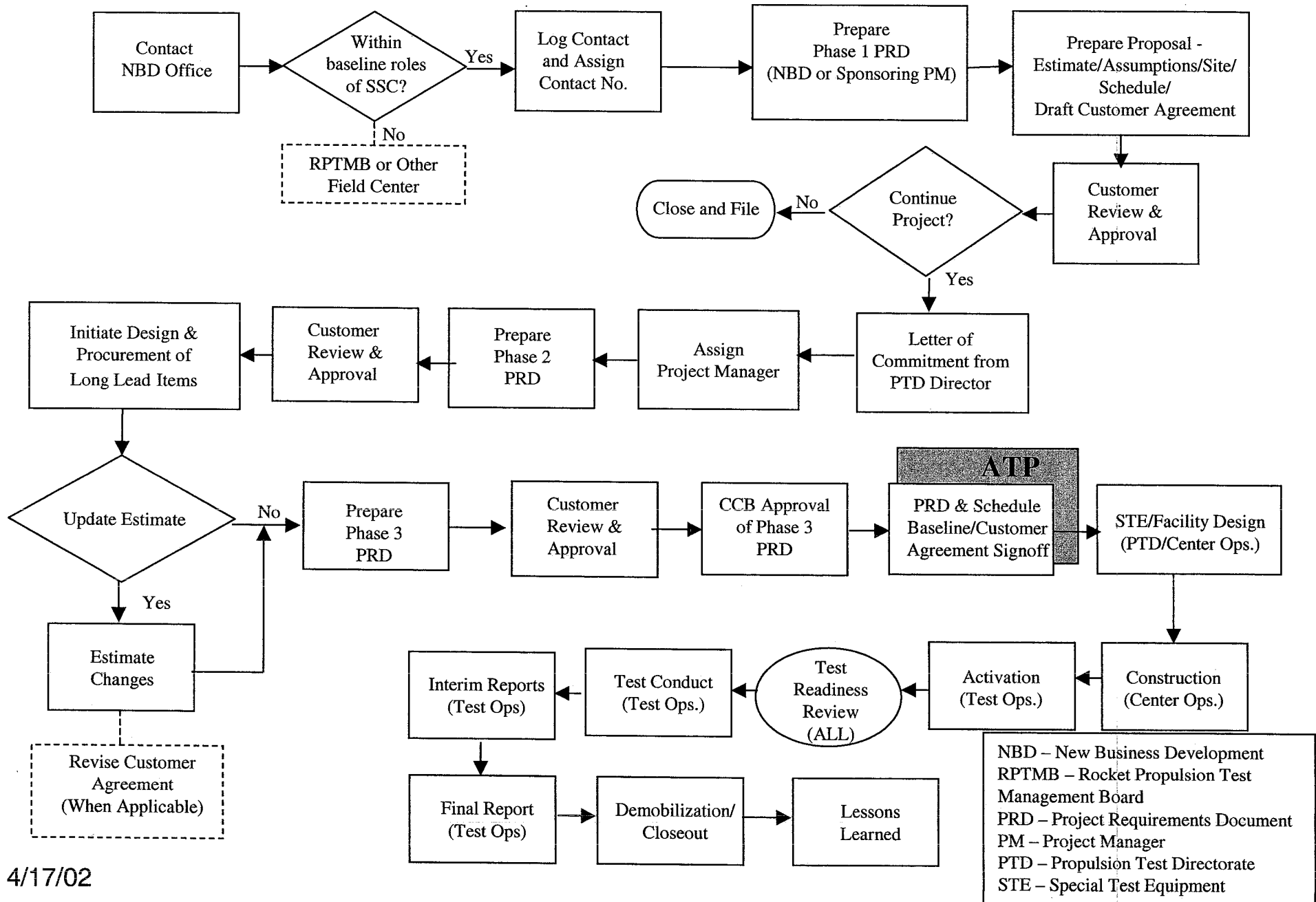
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*Stennis Space Center*

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- Ways to Contact
  - Phone
  - E-mail
  - Direct mail
  - Others
  
- Individuals
  - In your hand-out material
  - Usually New Business Development Office or RPTMB
  - Organization charts
  - Web base: Stennis Space Center

# Doing Propulsion Business w/ SSC



# Project X Status (PM)

## FY02 Cost Status

(\$ in Thousands)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	EAC
TOTAL PLAN	218	475	726	861	1,084	726	817	908	1,024	1,140	1,256	1,511	1,511
ACTUAL	218	475	726	861	1,084	0	0	0	0	0	0	0	
DELTA	0	0	0	0	0	0	0	0	0	0	0	0	

### Overview

G Technical –

G Schedule –

G Costs –

### Variance

### Status

### Issues/Actions

# Project X Schedule

WBS	TASK	2001			2002												Schedule-to-Date		Budget (\$K)			Index
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	Baseline	Actual	BCWS	ACWP	EAC	
1.0	Admin/Infra.																100%	100%				1.00
																			\$73	\$73	\$103	1.41
3.0	STE Design																100%	100%				1.00
																			\$102	\$102	\$120	1.18
4.0	Facility Const.																100%	95%				0.95
																			\$0	\$0	\$0	0
5.0	STE Const.																70%	70%				1.00
																			\$460	\$460	\$792	1.21
6.0	Test Ops.																60%	60%				1.00
																			\$373	\$55	\$630	6.87
7.0	Support																30%	30%				1.00
																			\$246	\$106	\$770	2.18
8.0	Logisitics																0%	0%				0
																			\$0	\$0	\$490	0
9.0	Maint.																0%	0%				0
																			\$0	\$0	\$21	0
	TOTALS																		\$1,254	\$796	\$2,571	

◆ PDR ▼ CDR — Baseline — Progress

Notes: BCWS=Budgeted Cost of Work Scheduled (i.e., Plan)  
ACWP=Actual Cost of Work Performed (i.e., Actuals)  
EAC = Estimate at Complete

Formulas:

Schedule index = Current/Plan = 35%/35% = 1.00

Cost index = Actual %Schedule/(ACWP/EAC) = .35/(8/100) = 4.38

Index Stoplight Metrics:

Green -- Index = or >1.0

Yellow -- 0.9<Index<1.0

Red -- Index<0.9

4/17/02



# Project X Wrap-up

## FY02 Financial

**Budget**                 **\$1,327K**  
**EAC**                     **\$1,327K**  
**Allocated (PAF)**   **\$1,085K**  
**Obligated**           **\$1,085K**  
**Costed**               **\$1,084K**

## Project Check List

NBDO	Plan	Actual
Space Act Agreement (SAA)	n/a	12/??/99
Handoff to Project Manager	n/a	8/??/99
<b>PM</b>		
Team Assignment Memo	8/??/99	8/??/99
Project Requirements Document, Rev 0	11/??/99	11/??/99
TTA or SAA (with EPR)	n/a	n/a
Detailed Schedule Baseline	01/??/00	01/??/00
Detailed PAF/Phasing Plan	01/??/00	01/??/00
Risk Management Plan		12/??/01
<b>CUSTOMER</b>		
Preliminary Test Plan	12/??/01	12/??/01
Final Test Plan	04/??/15	4/??/15
Instrumentation List	12/??/01	12/??/01
Test Article Delivery	03/??/01	03/??/01

Risk - Mitigation - Corrective Action					
	Item	Risk	Short Term Mitigation	Long Term Corrective action	Actionee
Y	1	10" Valve may not function properly after design modifications	Develop Action Plan to Repair	Rework pipe to fit different valve	
	2	Test Article may produce static spark during operation	Grounding fix implemented into design	n/a	n/a
Y	3	Propellant pressurization systems do not have redundant capability	Spare parts are maintained and preventative maintenance performed	Redundant systems are being procured	
	4	Multiple programs at E-1 Complex may create scheule conflicts	Coordinate schedules and prepare priority ranking strategy	Multiple shifts working and coordination between programs	

TTA – Technical Task Agreement  
 EPR – Estimated Price Report  
 PAF – Project Allocation Form

REPORT DOCUMENTATION PAGE		Form Approved OMB No. 0704-0188	
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		5c. PROGRAM ELEMENT NUMBER	
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